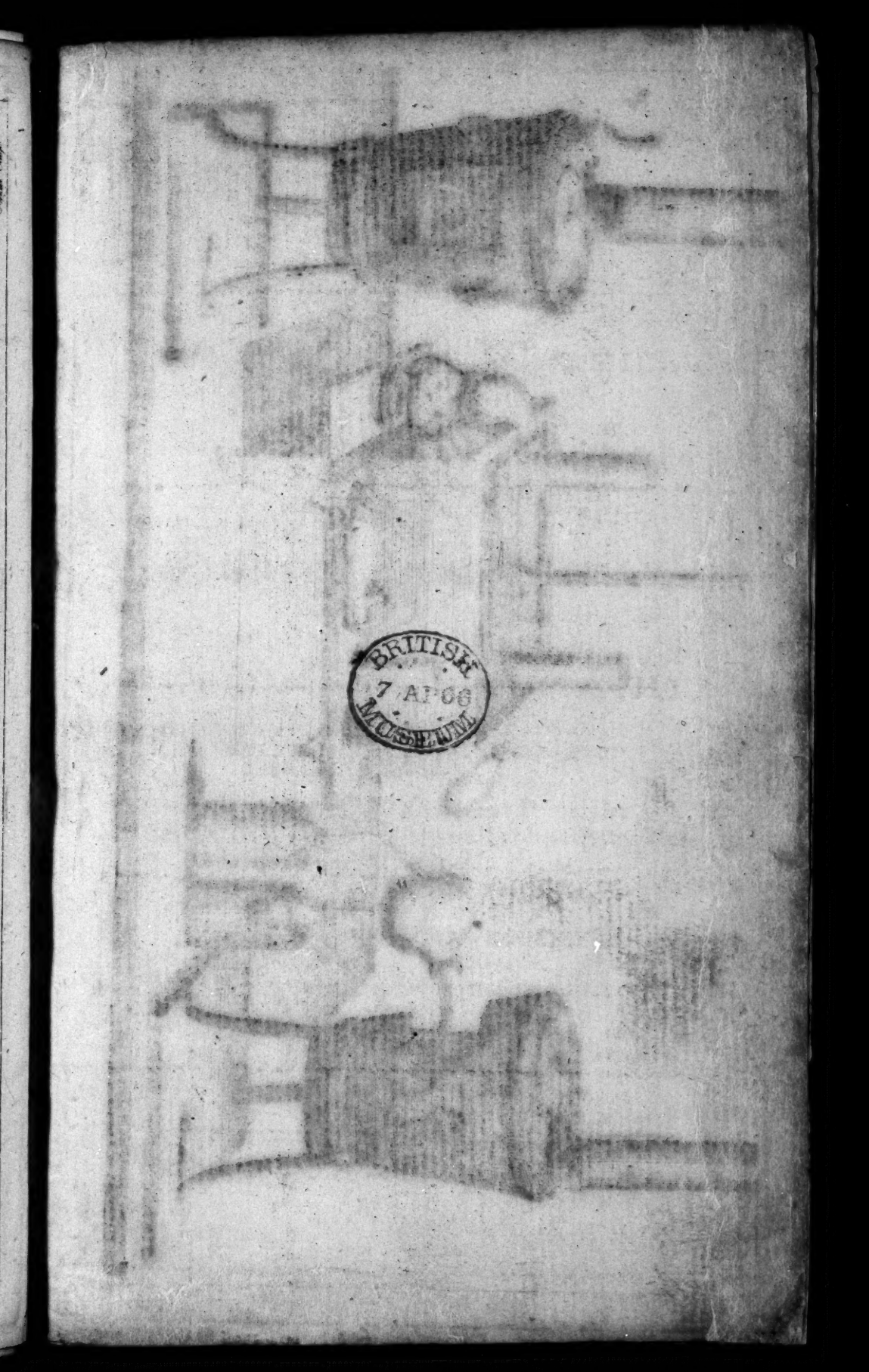

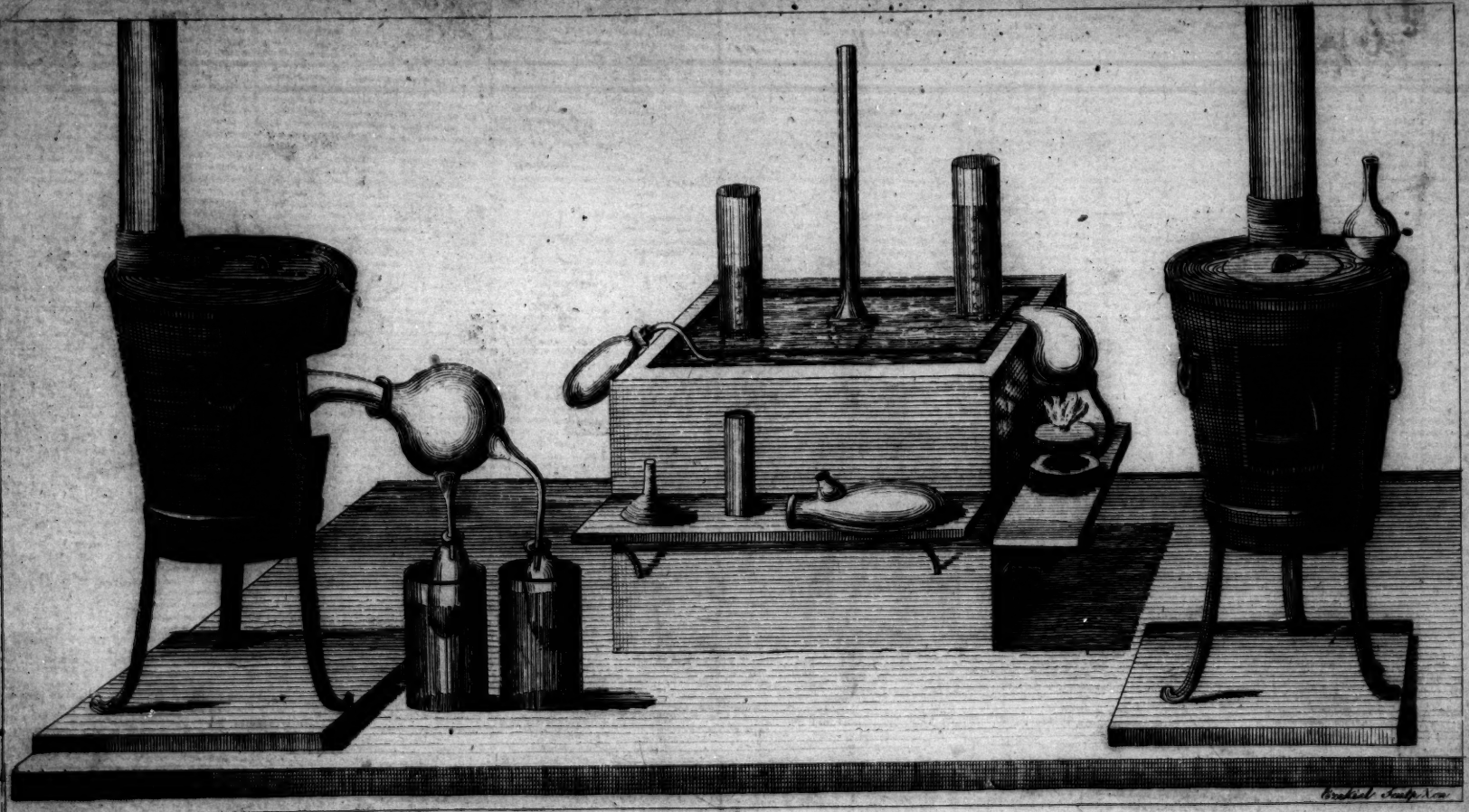

Joseph Hodgetts

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CONCISE ESSAYS

UPON VARIOUS

PHILOSOPHICAL and CHEMICAL SUBJECTS:

Proper to be read before or after attending

COURSES of CHEMISTRY,

OR,

EXPERIMENTAL PHILOSOPHY,

UNDER THE FOLLOWING HEADS:

Mechanics	Chemical Principles
Optics	Useful Tables of Attraction
Electricity	Solution
Astronomy	Specific Gravity, &c.

And many CHEMICAL PROCESSES,

With a Vocabulary adapted to modern Discoveries.

K

BY J. WARLTIRE.

LONDON: Printed for the AUTHOR.


BRITISH MUSEUM

CONCISE

ESSAYS

UPON VARIOUS

Philoſophical and Chemical SUBJECTS.

PART the FIRST.

A ſhort Explanation of the general Properties of Bodies, and the Mechanical Powers.

THE buſineſs of *experimental Philoſophy* is to enquire into, and inveſtigate the cauſes of the various appearances in nature by every kind of Experiment, and to make mankind wiſer and better.

All bodies are found to poſſeſs, or partake of the following general properties, viz. *Extenſion*, *Solidity*, *Diviſibility*, *Mobility*, *Inactivity*, *Attraction*, and *Repulſion*; and are capable of a very minute perceptible diviſion; for the Goldbeaters can extend a grain of gold into a leaf of 50 ſquare inches, and thoſe may be divided into two millions of viſible parts. Nature goes greater lengths; *Lewenbock* tells us there are more animalcules in the milt of a ſingle fiſh, than there are men upon the whole earth. This might be farther evinced by the ſmallneſs of effluvia from various bodies.

Motion is either abſolute (of itſelf) or relative, as having reference to ſome other motion; and is equable, when the body paſſes over equal ſpaces in equal times; or accelerated, when it conſtantly increaſes its motion, by the firſt impulſe not ceaſing to act.——Every body will, (by reaſon of its inactivity) continue in a ſtate either of

reſt, or of motion uniformly in a right line; except ſo far as, by a force impreſſed, it is compelled to change that ſtate.——Secondly, The change of motion is always proportional to the moving force impreſſed; and is ever made in that right line in which the force is directed.—Thirdly, Re-action is always equal to, and contrary to action. The force one body is capable of exerting upon another, is as its quantity of matter multiplied into its velocity.

ATTRACTION ſeems to be of ſeveral kinds; but it is at leaſt probable that each is an effect proceeding from the ſame cauſe.—Firſt, *Gravity*, which is evident between large bodies; as the earth and the moon, the ſun and planets, &c. Gravity accelerates equally the motion of a body, and the velocity is proportional to the time the body has been moving. The ſpace thro' which a body deſcends in one ſecond, if it moves without reſiſtance, is 16.13 feet. The above laws hold good if the body is deſcending upon an inclined plane; only the force acting upon it then, is to the abſolute force of gravity, as the height of the plane is to the length.—Secondly, *Cohesion*, which, by its ſtrength or weakneſs, occaſions the different degrees of *Fixity*, *Fluidity*, *Hardneſs*, *Softneſs*, and *Elaſticity*, and *water to riſe in capillary tubes*.—Thirdly, *Electric Attraction* is proportioned to the charge of electricity upon the conductor, and increaſes as the ſquare of the diſtance is diminiſhed.—Fourthly, *Magnetiſm* is peculiar to iron or its ore *; its force diminiſhing in an irregular manner, but near the inverſe proportion of the ſquares, as in the electrical attraction.—Fifthly, *Specific Attraction*, which will be particularly explained in Part the Second.

* Magnets are either natural or artificial; the natural magnet, or load-ſtone, has frequently ſeveral attracting points, called poles, but ſometimes only two; the artificial magnet has never more than two poles, but the attracting points are much diffuſed. A magnet ſuſpended upon a point, turns one of its poles northerly, and the other towards the ſouth; but the exact poſition varies conſiderably in a ſeries of years, in a manner ſomewhat reſembling the vibration of a pendulum.

Beſides

Beſides the above properties, bodies may be conſidered with reſpect to their *motion*, *quantity of matter*, or *diſpoſition to produce any conſiderable effect*. The *center of gravity* is that point in a body about which all the parts in any ſituation will exactly balance each other; and if the earth and moon by the intervention of gravity are conſidered as two connected bodies, their centre of gravity will be about two thouſand miles from the ſurface of the earth; about which point they both turn once a month. The mechanical powers are reckoned *ſix*; the *lever*, the *pulley*, the *wheel and axle*, the *inclined plane*, the *wedge*, and the *ſcrew*; though theſe diſtinctions do not ſeem wholly neceſſary. To compute the advantage gained by any machine, it is requiſite to find the velocity of the firſt and the laſt movers; as much as the one exceeds the other, ſo much is the advantage, an allowance being made for friction, which in moſt machines will amount to one-third of the computed effect.

Of the Atmosphere.

The *Air* or *Atmoſphere* extends round the earth, (a body about eight thouſand miles in diameter) as is ſuppoſed, to the height of four or five hundred miles; it decreaſes in denſity in a certain proportion upwards:—is *Fluid*, *Heavy*, *Elaſtic*, *Rarefiable* with heat:—is *the vehicle of ſounds*, (which move 1142 feet in a ſecond):—is *neceſſary to the growth of vegetables and to animal life*:—may be *vitiated* either *by the introduction of foreign matter*, or *by decompoſition*:—is *heavier at one time than another* by one-tenth of the whole weight. A column of a ſquare inch at the baſe, weighs fifteen pounds avoirdupoiſe, and will ſupport a column of water of two or three and thirty feet; of quickſilver, 29.5 inches. The weight of air to water is as one to 860, but by compreſſion its denſity may be made to exceed even that of quickſilver.*

* The Air-Pump acts by extracting the air out of a veſſel prepared for that purpoſe, as the condenſer operates by injecting into a receiver more air than it commonly contains. The barometer indicates the weight of the atmoſphere; the thermometer ſhews its heat, and the hygrometer, its ſtate with reſpect to moiſture and dryneſs. The ventilator was contrived by the moſt ingenious Dr. Hales, to extract vitiated air out of any cloſe place. The air-gun

Of Hydrostatics.

The ſcience of Hydroſtatics treats of the *nature*, *gravity*, *preſſure*, and *motion* of fluids in general, and of *weighing ſolids* in them. A fluid is a body that yields to a ſlight preſſure. Fluids preſs equally in all directions. The weight of a cubic foot of water is 62.5 pounds avoirdupoiſe. Water is compreſſible only in a ſlight degree, ſo far as experiments are at preſent of a nature to determine it. The ſpecific gravities of bodies are as their weight, bulk for bulk.

Of Light.

Light is a body conſiſting of very ſmall particles of matter; moves at the rate of near twelve millions of miles in a minute; or takes about eight minutes to move from the ſun to the earth: This was firſt diſcovered by Mr. *Reaumur*, from the appearance of the ſatellites of Jupiter when they were paſſing into, or out of, the ſhadow of that planet, and confirmed by the moſt eminent aſtronomers; it always moves in a ſtrait line; when it falls upon a reflecting ſurface, it is returned in ſuch a manner that the angles of incidence and reflection are equal; when directed upon a tranſparent body it is in part tranſmitted and in part reflected; if the tranſparent body be of an unequal thickneſs, it is refracted or drawn out of its rectilineal direction; whence the operation of the different kinds of lenſes, &c. By the refraction of the atmoſphere, the ſun is ſeen five minutes ſooner than than it otherwiſe would be at its riſing, and continues as much longer above the horizon, at ſetting; for the ſame reaſon, in countries near the poles it continues to be ſeen ſeveral days longer than it otherwiſe would. Common

(the invention of which I believe may be attributed to Otto de Guericke, but much improved by Mr. Boyle, and ſince by others) is conſtructed to diſcharge balls, &c. in a manner ſimilar to ſ w'er guns; and the preſent conſtruction ſeems to have as great an effect. The common air has been accurately examined lately; and means have been deviſed to determine its component parts. It appears to contain between a third and fourth of dephlogiſticated, an eighteenth of fixable, a large proportion of phlogiſticated air, and much water combined with them. Dr. Prieſtly has contrived an air-gage, or eudiometer, to determine the quantity of pure air in the atmoſphere.

light

light is ſeparable into *ſeven diſtinct colours*, viz. *red*, *orange*, *yellow*, *blue*, *green*, *violet*, and *indigo*; which properties are demonſtrable by the various optical inſtruments.*

Of ELECTRICITY.

ELECTRICITY is now arrived at ſuch a degree of perfection, that it may very juſtly be termed a ſcience in ſome meaſure known to the ancients, but of which we owe every ſatisfactory account to the moderns. It was in Sir *Iſaac Newton*'s time little underſtood; but when many ingenious perſons in ſeveral parts of Europe, particularly Mr. *Hawkſbee*, Mr. *Stephen Gray*, &c. began to direct their enquiries towards the ſecrets of this ſcience; their labours were rewarded with many material diſcoveries; the chief of which were:—Firſt, That ſome ſubſtances would *conduct* this power, and others would *not* †:—Secondly, If a *conductor* be ſuſpended by a *non-conductor*, the electric virtue might be communicated to it, from an excited piece of *glaſs*, *wax*, *amber*, &c. and would flow round it like an atmoſphere:—Thirdly, When this virtue was ſuddenly taken from either an excited ſubſtance, or any thing poſſeſſing it by communication, it appeared like fire, of this or that colour, according to its degree of ſtrength:—And, Fourthly, That it might be conveyed to very conſiderable diſtances, and loſe none of its wonderful properties.

* Optical inſtruments are very numerous; the principal is—The refracting teleſcope, the invention of *J. Lipperſheim*, of Middlebourg, in Zealand, about the year 1609; improved by *Galileo*, and made in great perfection by *Huygenius*. There is a conſiderable variety in the conſtruction of teleſcopes, which have their advantage for particular purpoſes; but the long ones are much in diſuſe ſince the reflecting teleſcope by Sir *Iſaac Newton*, and improved by Dr. *J. Gregory*, of Aberdeen, theſe being much more manageable than refractors. The invention of microſcopes was in conſequence of that of the teleſcope; they are of ſeveral forms; thoſe with ſingle lenſes have ſome advantage as to diſtinctneſs. Compound microſcopes have ſome particular conveniences, and are perhaps the beſt for common uſe; but undoubtedly the ſolar microſcope, invented by Dr. *Liberkun*, a Pruſſian, about the year 1739, is the moſt perfect, eſpecially as now improved, for viewing opaque objects, and magnifying fluids horizontally with achromatic glaſſes, by the author of this. The magnifying power of this inſtrument is amazing.

† The moſt perfect CONDUCTORS are metals, ores, water, wet ſubſtances, and a vacuum; and NON-CONDUCTORS are dry air, and every other dry ſubſtance, except as above.

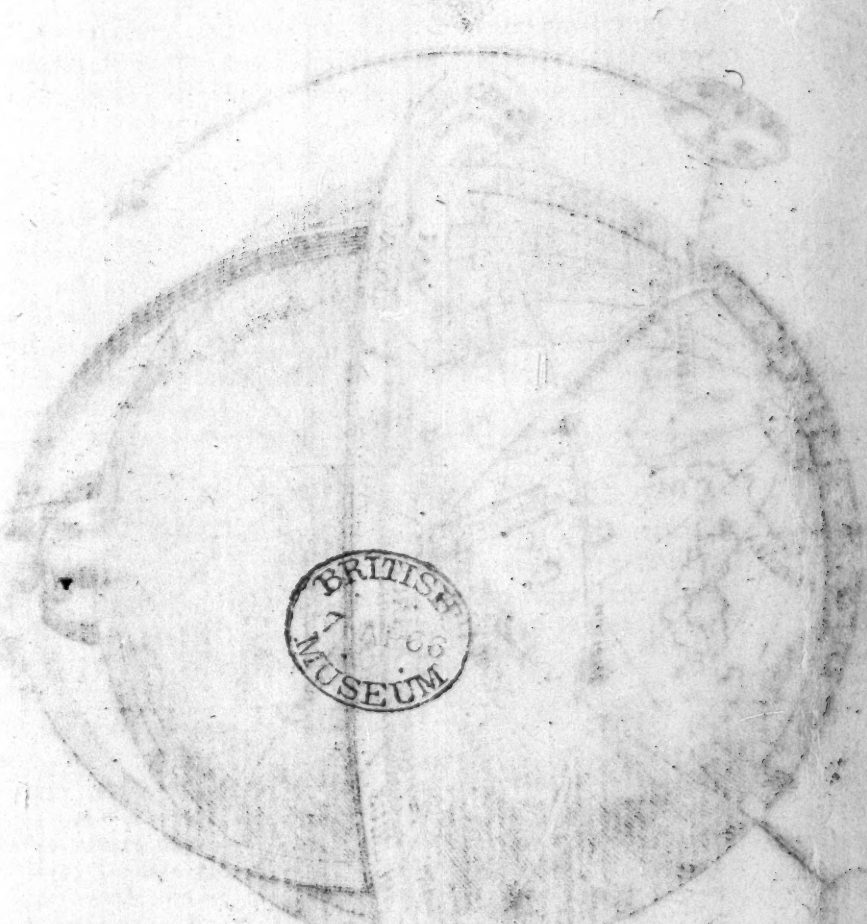
This

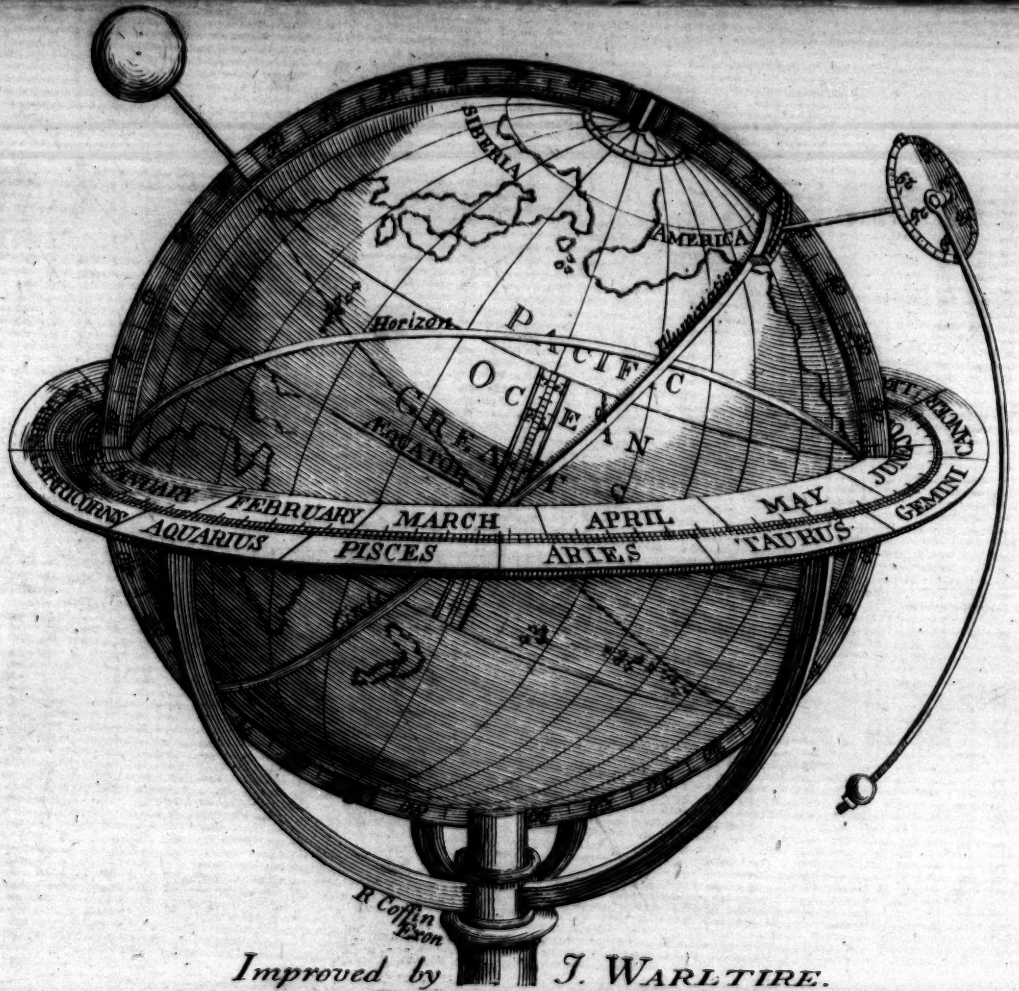
This was the ſtate of *Electricity* 'till about the year 1743; when Profeſſor *Muſchenbroek* accidentally diſcovered a method of increaſing its force in a very ſurpriſing manner. Having ſuſpended a cannon by non-conductors, with a vial of water depending from it, holding the bottle in one hand while he drew ſparks with the other, he found the force ſo much increaſed, as for ſome time to deprive him of his ſenſes. This diſcovery encouraged the learned to purſue their reſearches with more alacrity than ever; which has been productive of the following diſcoveries:—Firſt, That all bodies contain a neceſſary quantity of the electric fluid:—Secondly, A conductor may be electrized either *negatively* or *poſitively*; that is, *may be deprived of a part of its natural quantity*, or *have more than common accumulated upon it*:—Thirdly, That when any ſubſtance is *poſitively* electrified, its ſuperfluous fluid is drawn from the earth and things contiguous to it; and not from the air alone, as ſome perſons had imagined:—Fourthly, A body *negatively* electrified is attracted by *poſitive* electrification, and, while in that ſtate, is repelled by any thing in a ſtate of the *negative*; and the contrary:—Whence Fifthly, poſitive and negative electricity differ not *eſſentially*, but in *quantity*,—Sixthly, Excited wax robs of its fluid any conductor it is applied to; but glaſs communicates to it:—Seventhly, That the electric ſpark has been found efficacious in removing ſome diſorders incident to the human body:—Eighthly, A conſiderable diſcharge of it deprives animals of life, without leaving any marks of violence. It will ſet fire to inflammable ſubſtances, melt gold, and give polarity to, or deſtroy it in needles.

It has been lately diſcovered that thunder and lightning are produced by a diſcharge of electric fire, from or to the earth; or a cloud containing either more or leſs than its natural quantity; for the clouds are ſometimes in a negative, and ſometimes in a poſitive ſtate.

This is evinced, not only from the ſimilar appearance of an electrical diſcharge to a flaſh of lightning, and their like effects in killing animals, fuſing metals, rending bodies which reſiſt its free paſſage, &c. but it has, by means

of





Improved by J. WARLTIRE.

of a convenient apparatus, been drawn from the clouds*, and all the experiments made with it, that can be made with our electrical machines.

Of the Solar System.

The matter at and near the ſurface of the earth may be ſubmitted to actual experiment; but the bodies that compoſe the ſolar ſyſtem can only be *obſerved*, not being ſubject to any experiment. The order and laws of motion of the heavenly bodies, diſcovered by unexceptionable obſervations, conſtitute the ſcience, or true ſyſtem of aſtronomy, which was, perhaps, one of the firſt ſtudied by mankind, but has received conſiderable improvements in the laſt and preſent ages. Now, inſtead of being incumbered with uncertainties, it is by late Aſtronomers and Philoſophers (particularly the great Sir *Iſaac Newton*) rendered certain and demonſtrable. The old ſyſtems of aſtronomy were diſtinguiſhed by the names of their inventors; but the preſent ſyſtem, as being ſupported by demonſtration only, is called the true Syſtem of the Univerſe, or Solar Syſtem. Thoſe who adhere to this ſyſtem conſider the heavenly bodies as being nearly ſpherical, moving about a center or point, in orbits almoſt circular. In the infinitely extended ſpace there are ſuppoſed to be many collections of theſe bodies; ſeveral of which being ſmall with reſpect to ſome other, move round it in different lengths of time, proportioned to their diſtances from the center of motion. Some of theſe bodies, which are

* Dr. *Franklin*, after publiſhing his conjectures concerning the ſameneſs of lightning and electricity, raiſed a kite in a thunder ſtorm, and was ſoon convinced of the reality of his conjectures, by drawing a ſpark from a key hanging to the line with which he held the kite. He deduced a method from this experiment to prevent the uſual fatal accidents which happen to buildings, eſpecially in the part of the world where he reſided (North America), by fixing a metallic conductor in ſuch a ſituation as to reſtore the equilibrium between the earth and clouds, and avert it from the neighbouring bodies. Electricians reſiding in diſtant countries have had opportunities of obſerving a great variety of appearances, which could not have been obſerved in any one place; and by their communications, have enabled one another to account for many phœnomena that muſt have eſcaped an individual.—Electricity has been applied to account for whirlwinds, water-ſpouts, ignis-fatuus, northern lights, ſhooting ſtars, earthquakes, &c.

circulating

circulating round that fixed in the center of their orbits, are found to have yet ſmaller ones revolving about them. According to that part of this ſyſtem, which is ſupported by probable conjecture only, every fixed ſtar, or moſt of that multitude of ſtars we behold, beſpangling the wide expanſe of the firmament, in a ſerene winter evening, are thought to be ſuns * at vaſt diſtances from one another, diffuſing light and heat to an inconceivable number of inhabited worlds. But notwithſtanding theſe reflections greatly extend our ideas of the creation, and omnipotence of the Supreme Being; yet as we do not know much about it with certainty, and there being ſufficient room for reflection where we are better acquainted, I proceed to explain our own ſyſtem, and the principal phænomena ariſing from the motions and conſtitutions of thoſe bodies which compoſe it. Theſe are ſeventeen in number, ranked in three claſſes:—Firſt, The central ſun, round which all the others move:—Secondly, The primary planets, or thoſe that move round one center only:—Thirdly, The ſecondary planets, or ſatellites, which move round ſome of the primaries, and with them in their courſe about the ſun:—To theſe may be added the comets, which move in very eccentric orbits. The ſun is a body of immenſe magnitude, whoſe diameter is equal to a hundred ſuch globes † as this we inhabit, laid in a right line; and its whole bulk or ſolid content is more than a million of our terreſtrial balls. It turns round its axis in twenty-five days and a quarter, but never moves ſenſibly out of one place. This vaſt body diffuſes light to the planets, to warm and enliven animals and vegetables. With a good teleſcope, many dark ſpots may be ſeen on the face of the ſun; they are ſuppoſed to be deep cavities alternately formed and refilled, ſimilar to ſome vol-

* Light, according to the beſt obſervations, moves at the rate of near twelve millions of miles in a minute; and notwithſtanding its amazing velocity, would be ſeven years coming from the neareſt fixed ſtar to us.

† The diameter or diſtance from one ſide of the earth to the other is almoſt eight thouſand miles. In ſpeaking of the diſtance and magnitudes of the other bodies, they are compared with our earth as a meaſure. However, the earth's diameter from pole to pole, is a little leſs than from one ſide of the earth's equator to the other; and the ſame is obſerved of the planet Jupiter.

canos

canos upon this earth. *Mercury* is the neareſt planet to the ſun, diſtant from that luminary four thouſand of our earth's diameters, moving round him in eighty-four of our days with the amazing velocity of an hundred thouſand miles in an hour. His diameter is about one third of the earth's. This planet's orbit being ſmall, compared with that of the earth, is the reaſon he never appears very diſtant from the ſun, but conſtantly accompanying him in his ſeeming annual courſe; being ſometimes on the weſtern, and ſometimes on the eaſtern ſide of him. This ſtar always moves round his center of motion the ſame way, that is, from the weſt towards the eaſt, with nearly an uniform velocity; but as ſeen from the earth, ſituate conſiderably farther from the ſun than his orbit, he appears to move ſometimes towards the right, and ſometimes towards the left, with very different degrees of motion; and when at his greateſt apparent diſtance from the ſun appears quieſcent. Mercury viewed thro' a teleſcope, is ſeen in all the various ſhapes of the moon, and has often been obſerved to paſs over the ſun's diſk in form of a dark ſpot in the ſun. *Venus* is the next beyond Mercury, in order, from the ſun; ſhe deſcribes her annual circuit round him in two hundred and twenty-four of our days; in which ſhe turns about her own axis nine times and a quarter, which is once in twenty-four days and a quarter with us.* The planet Venus, becauſe her orbit is removed farther from the ſun than that of Mercury (being ſeven thouſand three hundred and ſeventy-five of the earth's diameter), appears more than as far again from the ſun, when at her greateſt diſtance or elongation, than Mercury does; and when ſhe is about one third of that diſtance to the right of the ſun, riſing before it, ſhe begins to become a glorious morning ſtar, and when ſhe is as far to the left, ſhe ſhines in the evening with amazing ſplendour. With the teleſcope ſhe appears in the various ſhapes of the moon; paſſing over the ſun's diſk as a dark ſpot, and is direct and retrogade in particular parts of her orbit, in common with Mercury. The *Earth* is the next planet above Venus, diſtant from

* It is doubtful whether Venus revolves about her axis in nearly 24 days or 24 hours, becauſe the obſervations have not been made with ſufficient accuracy.

the

the ſun ten thouſand of its own diameters. It moves round the ſun once in a year, or three hundred and ſixty-five days and a quarter, which is called its annual motion. And the motion about its axis is performed in twenty-four hours, or one day; whence it is termed the *diurnal motion*. The firſt of theſe motions, joined to the inclination of the earth's axis, cauſes the change of ſeaſons; and the other occaſions day and night; the riſing and ſetting of the moon and ſtars, &c. The *Moon* is a ſolid opaque globe; diſtant from us twenty-eight of the earth's diameters, and about forty times leſs. She moves round our globe as a center, in twenty-ſeven days and a third, in which time ſhe turns once about her own axis, always keeping the ſame ſide towards us. But becauſe the moon is carried round the ſun with the earth, ſhe takes up twenty-nine days and a half from one change to another. The ſurface of the moon ſeen through a teleſcope, has the appearance of ſeas, lakes, iſlands, mountains, vallies, &c. and is undoubtedly ſurrounded by a ſubtile atmoſphere.

The moon ſhining with a borrowed light, which ſhe derives from the ſun, can have no more than one hemiſphere illuminated at a time; and in conſequence of her motion about the earth, the enlightened ſide is alternately turned to, and from us. This occaſions her increaſe and decreaſe. An eclipſe of the ſun is cauſed by the moon interpoſing her dark body between the ſun and the earth. And the moon is eclipſed by paſſing through the ſhadow of the earth. The general uſe of the moon ſeems to be, by her attractions, to raiſe and agitate our ſeas and atmoſphere; thereby keeping them in a healthy ſtate.*

* The tides are to be accounted for by both the ſun and moon attracting the earth. At the time of change, the ſun and moon attract the waters, on the ſide of the earth next to them, with a greater force than the earth itſelf is attracted, and the waters on the other ſide with a leſs, in the ſame proportion; whence the earth leaves the water on the ſide oppoſite to thoſe bodies as much as the waters next to the ſun and moon leave the earth; conſequently the ſea will riſe equally high on both ſides of the earth, rnd ſink equally low on both ſides the line of attraction. But the earth turning round its own axis, and both it and the moon moving in orbits round the common centre of gravity between them, there will be two ebbs and two floods in a little more than twenty-four hours. The ſun

Next

Next above the earth is ſituate the planet *Mars*, at the diſtance of about fifteen thouſand diameters of the earth from the ſun. He turns about his axis in a little more than twenty-four hours; and about the ſun in ſix hundred eighty-ſeven of our days. He appears to the inhabitants of the earth ſometimes larger than at others, owing to the diameter of the earth's orbit bearing ſo ſenſible a proportion to that of Mars. *Jupiter* is placed at the diſtance of fifty-three thouſand diameters of the earth from the ſun. His own diameter is about ten of the ſame meaſure. He moves round the ſun in eleven of our years, and three hundred and ſeventeen days. He is ſurrounded with four moons moving about him in different periods of time. The uſe of theſe moons or ſatellites, is the ſame as that of our moon; to enlighten Jupiter's nights, and to raiſe and agitate his ſeas and atmoſphere. Theſe ſatellites ſeen from hence with a good teleſcope, appear to move in different directions, and with different velocities; and are often obſerved to paſs into the ſhadow of Jupiter. By theſe eclipſes the longitude of moſt of the principal places on the earth is determined; and by them the motion of light was firſt diſcovered, and proved to come from the ſun to us in near eight minutes. Our earth and moon, Mars and the inferior planets, would be entirely unperceived at Jupiter; and had it not been for the noble invention of the teleſcope, we ſhould have been abſolutely unacquainted with

and moon acting in the ſame direction, raiſe the waters higheſt, when on the other parts of the earth they are the ſhalloweſt poſſible. When they act at right angles to each other, (the moon being in the firſt or laſt quarter) they both give the waters a tendency to riſe, but they riſe only by the difference of the attractive forces, which is moſt towards the moon. When the moon is at full, the tides are nearly as high as when the ſun and moon act in the ſame direction at the change; for as the ſun checks the earth's motion towards the moon, the moon by her attraction checks the waters (being at liberty) next to her, and prevents their moving towards the ſun; which added to the effect producible by the moon if the earth were at liberty to move as much as the waters on the ſide next to her, will be nearly equal, on the ſide next the moon, to the effect produced by both ſun and moon at change. The waters next the ſun being left behind by the ſuperior action of the moon upon the earth, and alſo checked at the ſame time by the ſun more than the earth itſelf, will by theſe joint effects be raiſed as high as on the oppoſite ſide.

either Jupiter's ſatellites, or his diurnal motion*. *Saturn*, the moſt remote planet in our ſyſtem, is the diſtance of ninety-ſeven thouſand of the earth's diameters from the ſun. As to bulk, he is conſiderably leſs than Jupiter. Saturn is ſurrounded by a large ring and five moons. The uſe of his moons is the ſame with that of the ſatellites of Jupiter; and his ring is a peculiar contrivance to collect the ſcattered rays of light, and condenſe them upon the body of the planet, which, without this proviſion, would receive no more than about one ninetieth part of the light and heat our earth does.

The ſun and moſt of the ſtars are fixed with reſpect to one another, and at an immenſe diſtance aſunder; ſo that as the earth moves round the ſun, the ſun appears to us to deſcribe a track amongſt the ſtars, which is called the *ecliptic*. The *orbits* or courſes of the planets are not in the ſame plane with the ecliptic; but inclined to it, each croſſing in two points, called the planet's *nodes*. Their orbits are not exactly circular, but of an elliptical form; the ſun being in one of the focuſſes of the ellipſis, or a little nearer one extremity than the other; and they all move round it from weſt to eaſt. As the preceding diſtances of the heavenly bodies are given in round numbers, the following are the diſtances, magnitudes, &c. as determined by the late tranſit of Venus. The Earth's mean diſtance from the ſun is found to be 95,173,000 Engliſh miles; Mercury's, 36,841,468; Venus's, 68,891,486; Mars's, 145,014,148; Jupiter's, 494,990,976; and Saturn's, 907,956,130. The times in which they revolve about the ſun are, Mercury, 87 days, 23 hours; Venus, 224 days 17 hours; the Earth, 365 days, 5 hours, 49 minutes; the Moon goes round the earth, from change to change, in 29 days, 12 hours, 44 minutes; Mars, 686 days, 23 hours; Jupiter goes round the ſun in 4332 days, 12 hours; his neareſt ſatellite moves round him in 42 hours, 36 minutes; the ſecond in three days, 13 hours, 15 minutes; the third in 7 days, 3 hours, 59 minutes; the fourth in 16 days, 18 hours, 30 minutes. Saturn goes round the ſun in 10,759 days, 7 hours; the

* Jupiter moves round his axis in 9 hours, 56 minutes; his polar diameter being to his equatorial as 12 to 13.

neareſt

neareſt ſatellite goes round him in 45 hours, 19 minutes; the ſecond 2 days, 17 hours, 40 minutes; the third in 4 days, 12 hours, 25 minutes; the fourth in 15 days, 22 hours, 41 minutes; and the fifth in 79 days, 7 hours, 48 minutes. And hence the diameters in Engliſh miles are as follows: the Sun 895,000; Mercury 3050; Venus 7440; the Earth 7970; Mars 5240; Jupiter 94,500; and Saturn 78,300. The hourly motions of the planets in their orbits are, Mercury 109,699; Venus 80,295; the Earth 68,243; Mars 55,287; Jupiter 29,083, and Saturn 22,231 miles.

GALILEO diſcovered the ſpots in the ſun, and its motion about its axis in 1616. The phaſes of Venus were diſcovered by the ſame in 1611. M. de la Hire firſt obſerved the tranſits of the fixed ſtars at noon-day 1666, Dr. Hook and Caſſini diſcovered the rotation of Venus about her axis, and ſpots in Mars 1666, and alſo his rotation; but the phaſes of Mars were diſcovered by Galileo about the year 1636. Galileo ſaw the four ſatellites of Jupiter 1610. Jupiter's belts were obſerved 1630, Caſſini ſaw ſpots on Jupiter and determined the time of his rotation in 1665. Galileo diſcovered Saturn's ring 1610. Mr. Hadley and Mr. Pond diſcovered belts about Saturn. In 1655 Huygenius diſcovered the outermoſt of Saturn's ſatellites: the reſt were diſcovered by Caſſini about 1686. Galileo diſcovered nebulous ſtars 1615.

PART the SECOND.

An Introduction to GENERAL CHEMISTRY, *under the following Heads*, viz.

1. *A Deſcription of Inſtruments proper for a repetition of experiments relating to moſt Chemical Facts yet diſcovered.*

2. *A Deſcriptive Catalogue of ſuch Subſtances as are moſt frequently required to make Miniature Experiments.*

THE neceſſity of reading much and making expenſive experiments has greatly contributed to prevent many artiſts, whoſe profeſſion is ſome particular branch of Chemiſtry, from underſtanding the theory of their daily employment, and of courſe cuts them off from every poſſibility of improvement, except, as it ſometimes may happen, accident points out an advantage to them. It is hoped artiſans will make, by peruſing the following pages, and by attending to the experiments and explanations in the author's courſes, improvements in their reſpective branches, at a very little expence and trouble.

The Natural Philoſopher who has attended to little more than the mechanical operations of nature, will doubtleſs be equally pleaſed with explanations of ſome of the chemical proceſſes that are continually conducting within the earth and in the atmoſphere. The laws of motion are applicable to large maſſes of matter; but Chemiſtry explains the relation which the minuteſt parts of a body have to one another.

DESCRIPTION *of a* GENERAL FURNACE *for* EXPERIMENTS.

THIS Furnace is conſtructed with ſheet iron and copper; the body of it is the fruſtum of a cone whoſe depth is 11 inches, and not riveted but grooved: the ſmalleſt diameter is 6½ inches, the edge being turned inwards to ſupport a common grate of bar iron: the largeſt diameter

or

or cover is 10¼ inches, through which are two holes as far from one another as poſſible; the wideſt is 5 inches, to be covered with an iron plate or to receive a copper pan, &c. the ſmalleſt is 3 inches wide and is ſurrounded by a ring to keep the lower end of a copper tube ſteady, which is made in three lengths to ſhut one under another, to put them into a common chimney; the whole length of the flue is 62 inches, and it's diameter 3⅛; it is made to ſlip eaſily into the above ring. In the front of the furnace, 2¼ inches above the bottom, is an opening 3¼ inches ſquare, occaſionally to be covered with a ſlide which ſhuts down before it. The furnace may be ſupported by a trivet made for that purpoſe, but room muſt be left for a free current of air. I have lined theſe furnaces with a mixture of burnt and unburnt Stourbridge clay, in which caſe the furnace muſt be made a little larger in all it's dimenſions except the height; but I commonly uſe them unlined, and have burnt in one of them at leaſt one hundered buſhels of two thirds coak and one third charcoal, which is the uſual fûel, and it does not want any repair. When all the openings through which the air ſhould not paſs, are cloſed, a heat may be raiſed ſufficient to readily melt four ounces of copper.* When the furnace is to be uſed for boiling, with the ſtill, or a ſand-heat, for evaporation, ſubliming, &c. the fuel is to be put into it through the front; but at other times it may be put into it at the top.

A chemical apparatus would be very defective if not furniſhed with a tub to collect through water ſuch air as it will not diſſolve, and a trough of quickſilver to confine

* A pair of bellows may be uſed ſometimes to raiſe a greater heat than common in the furnace. A blow-pipe, conſtructed in the ſame manner with that the author uſes in his courſes, is very convenient to bend glaſs, blow bulbs upon tubes, and to raiſe the flame of a lamp ſufficiently to reduce ſmall portions of the ores of metals, and to make experiments upon vitrification and with ſolders, becauſe any perſon may work with it even if they have never ſeen one before. A ſpirit lamp is very uſeful when put under a ſtand, to ſupport a retort or other veſſel containing ſomething to be heated.—N. B. Since writing the above article, the moſt refractory copper ores have been ſmelted in it with eaſe; and if enlarged but 1½ inch at the top, and all the other dimenſions proportionally, caſt iron may be melted in it, and ſome of the leſs refractory iron ores reduced.

ſuch as is ſoluble in water, with the neceſſary cylindrical jars, round bottomed vials, &c. of different ſizes. There are many other little articles neceſſary to form a chemical apapratus; as, *burning-glaſſes, thermometers, the pyrometer, electrical machine, air pump, microſcopes, ſcales, weights,* &c. which perſons accuſtomed to philoſophical enquiries are commonly provided with. *Vials with glaſs ſtoppers, plain tumbler-glaſſes, white baſons and pans, glaſs mortar and peſtles,* and *ſmall firm boxes to contain dry drugs, are conſtantly wanting*, all of which I put into larger caſes, but in ſuch a manner that one article can be removed without diſplacing any of the reſt.

PROCESSES *to be conducted by means of the* FURNACE *and it's Appurtenances.*

BOILING.

THERE are two methods of conducting this Proceſs: the *boiler*, *round-bottomed vial*, or *matraſs* may be expoſed to the immediate action of the fire, or the veſſel containing the ſubſtance to be boiled, may be put into water or ſand with which the boiler is almoſt filled. Pruſſian blue and weak vegetable alkali may be boiled together in a glaſs veſſel over the naked fire, to produce the Pruſſian lixivium; but when a ſtrong ſolution of any ſalt, that is more ſoluble in hot water than cold, is required, it is beſt to plunge the containing veſſel into the boiler of water; the ſame may be obſerved when any thing is to be boiled in ſpirit of wine, or when the more volatile eſſential oils are to be heated.

EVAPORATION.

THIS Proceſs may depend upon heat alone, or jointly upon heat and the diſſolving power of a current of air; in all evaporations where the vapour is loſt, ſmall pans of pottery, ſilver, gold, or glaſs, are reſted upon the top of the furnace, with a little aſhes under them to prevent the too ſudden action of the heat. By this Proceſs water may be ſeparated from alkaline ſalt, or a redundant acid from any thing it adheres to, &c.

SUB-

Sublimation.

When one ſolid is mixed with another more votatile than itſelf and heat applied to ſeparate them, that which is forced off becomes ſolid again with leſs heat, and may be collected. Gum Benzoine contains a ſubſtance more votatile than itſelf, called the Flowers of Benzoine, which may be ſeparated from it by this proceſs. Sulphur may be collected from pyrites in the ſame manner. The ſubſtance to be operated upon is to be put into a pan proper to receive it, and a tall inverted glaſs over it, which is to collect the ſublimed matter.* Camphor may be ſublimed in like manner.

Distillation.

This is performed ſeveral ways: a common copper ſtill may be put into the furnace through the large opening at the top, and is proper to diſtil liquids that do not corrode copper or it's tinning; as when ſpirit of wine is to be diſtilled from water, or water from any thing it contains that is volatile. A glaſs retort may be put into the ſand-pot and it's beak joined to a receiver, and is proper to diſtil ſpirit of nitre, or ſalt, from ſalt-petre or common ſalt, when mixed with the vitriolic acid; or to diſtil æther from a mixture of alkahol and the acid of vitriol, &c. A retort of glaſs or earth may be put into the furnace, and it's beak may paſs through the ſquare opening in the ſide; and is proper to diſtil ſuch things as require a great heat, as in the ſeparation of mercury from cinnabar mixed with iron filings; detaching the dephlogiſticated air from nitre, &c.†

Cupellation.

This Proceſs is totally different from any of the preceding articles: it conſiſts in vitrifying lead ſo far as to convert it to litharge, upon bone aſhes which abſorb it,

* Calcination has great affinity with ſublimation, excepting that the detached ſubſtances are not uſually collected: this proceſs may be performed by expoſing the materials to the naked fire in ſmall iron or earthen pans; as in the expulſion of ſurphur or arſenic from lead, copper, iron, or cobalt ores, which may be collected again.

† Sometimes the ſubſtances to be diſtilled are of ſo tender a nature that they will not bear to be expoſed to a naked fire; in that caſe the ſtill or retort may be immerſed in the boiler of water adapted to the furnace.

and

and at the ſame time any of the baſe metals, which are alſo vitrified; but if the quantity of lead he ſufficient, no part of the ſilver or gold will ſink into theſe aſhes. To perform this proceſs, I introduce an iron muffle at the ſide of the furnace quite acroſs it, to contain the teſt, and then ſurround the whole with burning coals; ſilver in the ſtate of current coin may be made fine by putting it upon the teſt with double its weight of lead: the ſame of gold, or copper holding iron.

Fusion.

This ſimple proceſs is performed by putting a crucible down through the top of the furnace upon a piece of tile to keep it from the grate, and then to raiſe the fire high enough to melt the included ſubſtance; if ſilver ſolder were to be prepared, two parts of fine ſilver may be mixed with one of very malleable braſs, and melted with a little borax†; or litharge and charcoal duſt treated in the ſame manner will produce malleable lead.

N. B. Numerous chemical proceſſes may be conducted in the common heat of the atmoſphere, which conſiſt in barely mixing different ſubſtances together, and the change produced is commonly immediate; ſome of theſe are extremely amuſing, eſpecially when joined with ſuch as are uſually made with different kinds of air collected through water or quickſilver‡; a lamp heat is uſeful in procuring many of theſe airs.

There are diſtinctions amongſt chemiſts which ought to be underſtood; ſome of which are the following:

Diffusion.

Some ſubſtances may be mixed, and not have any tendency to form a new arrangement, or to be diſperſed, but are merely blended together, and retain all their ſeparate properties; ſometimes they preſerve their tranſ-

† When metals are to be melted that require but a low heat, ſmall iron diſhes may be commodiouſly employed; as alſo to melt pure gold and ſilver, but not that which is alloyed much.

‡ As fixable air may be expelled by heat and received thro' water, from mild magneſia, and marine acid air may be expelled from ſea ſalt mixed with the acid of vitriol, and received through quickſilver.

parency;

parency; as ſugar and water, ſalt and water, camphor and ſpirit of wine; they are often turbid, as expreſſed oil and water; or hazy, as water floating amongſt air, or when hot air paſſeth through that which is cold; or knotty, as water frozen during the time particles of earth are floating in it, or in the imperfect union of iron and copper, and ſometimes the different parts of caſt iron.—This kind of mixture is not unfrequently called Mechanical Mixture, which, however differs from Diffuſion becauſe it wants uniformity.

Change *of* Properties *in a* Body.

The Properties peculiar to any ſubſtance cannot be increaſed or diminiſhed, but by ſeparating ſomething from it, or by communicating ſomething to it; and to procure the change,—1. One of the bodies employed muſt be fluid, in the manner of melted glaſs, metal, water, ſteam, or air;—2. The fluid body muſt attract ſome part of the ſolid; or if they are both fluid, they muſt attract ſome part or the whole of one another;—3. The change may be effected, and yet the ſubſtance that brought about the change may not continue it's union with the body upon which the alteration is wrought;—4. It is not to be expected that all the properties of a compound ſhall be a mean between the properties of the ingredients of which it is formed.

Solution.

It is obſervable, that ſome bodies, when favoured by a proper degree of heat and fluidity, attract one another, and form compounds poſſeſſed of properties different from thoſe of the ingredients; that commonly during the proceſs, an increaſe of heat or cold is perceivable, and when finiſhed, the ſum of the bulks of the ingredients before union, is not always the ſame with the compound; as, marine acid and foſſile alkali conſtitute bay ſalt, a ſubſtance that differs much from the ingredients its properties; a mixture of ſtrong vitriolic acid and a ſaturated ſolution of ſalt of tartar, produce vitriolated tartar, and the union is attended with much heat; but a mixture of 50 meaſures of alkahol and 50 of water is colder, and the compound will want ſomewhat of the bulk of the ingredients.

dients. It ſometimes happens that a ſubſtance that formed an union with ſome other, is ſeparated from it when a third joins to it; as, when an eſſential oil is diſſolved in ſpirit of wine, and theſe mixed with water, a ſeparation of the oil is very viſible, which may be inſtanced by mixing ſpirit of wine with well rectified ſpirit or oil of turpentine, in the proportion of eight and one, which will be a true uniform ſolution, but twice the quantity of water, or leſs, will effectually ſeparate them, and the oil will ſwim. Many Chemiſts have attributed more to the action of one body than to another, in promoting this union, &c. but it appears to me that the one attracts or repels another reciprocally; and notwithſtanding ſo much has been attributed to the agency of acids and alkali's, they evidently act no other way than lime and clay melted down together, which may be eſteemed acid and alkali to one another as much as the vitriolic acid and ſalt of tartar; ſo may common air and phlogiſton, as much as marine acid and ſal-volatile. All bodies that unite, operate in the ſame manner, but not with the ſame force; and this is the foundation of the tables of attraction.

Causticity.

This implies a property of ſome bodies to corrode or diſſolve animal ſubſtances, and belongs to all that will in any degree deſtroy their texture. Quick-lime and the alkali's when deprived of fixed air, diſturb animal ſubſtances by abſtracting their fixed air; but the lunar cauſtic and blue vitriol appear to act upon, and diſſolve the whole of them.

Decomposition.

Among the antient Chemiſts, heat was the great agent of decompoſition; but the moderns have more frequent recourſe to intermediums. Heat alone can only ſeparate thoſe bodies that are differently volatile, upon the principle of ſome ſpecies of diſtillation; but an intermedium by joining one of the ſubſtances in a compound, will often ſet the reſt at liberty. A compound intermedium is ſometimes employed when a ſimple one will not perform the purpoſe; and in this caſe, the elements of both compounds

pounds ſeparate, and form new combinations. The antient method of decompoſition may be inſtanced in the proceſs of burning lime, where the heat expels both the water and the fixed air from the limeſtone; and the ſecond in the calcination of lead, by forcibly driving a current of air over the ſurface of it while melted, when the air acts as an intermedium to diſſolve the phlogiſtic matter. The third method of decompoſition may be illuſtrated by mixing a ſolution of ſal-ammoniac with a ſolution of mild fixed alkali, when the produce will be digeſtive ſalt of ſylvius, or ſea ſalt (according to the fixed alkali), and mild volatile alkali: in this caſe the acid in the ſal-ammoniac unites with the fixed alkali, and the fixed air with the volatile alkali. It is obvious that, when an intermedium is employed, there is not only a ſeparation produced, but alſo a freſh combination of ſubſtances; whereas when a decompoſition is effected by heat alone, there is a ſeparation without a new combination.

Crystallization.

This appears conſtantly to take place, and is attended by expanſion, when bodies paſs from a fluid to a ſolid ſtate, whether by cooling, abſtracting moiſture, or by the addition of any thing elſe; as water at the inſtant of freezing expands about $1\frac{1}{10}$, and is regularly figured at the ſurface; and iron and other metals are known to expand in a ſimilar manner; common ſalt will collect in large cryſtals at the ſurface of a ſolution of it during evaporation; ſome ſalts, which receive much water into their cryſtals, will continue diſſolved in water of a certain heat, but cryſtallize when it cools; as the wonderful ſalt of Glauber; and a like effect is produced by adding ſpirit of wine to a ſolution of ſome ſalts; as to Epſom ſalt diſſolved in water, by detaching the aqueous fluid from it; but fixed air occaſions the lime in lime water to cryſtallize by detaching the lime from the water, which when ſaturated with air with rediſſolve the lime ſtone.

Chemical Principles.

Since Chemiſtry has been paid due attention to as a ſcience, Chemiſts have endeavoured to fix upon a certain number

number of ſubſtances, which they have termed Elements or Principles: ſome have thought theſe to be earth, water, air, and fire: others imagined it ſufficient to divide all bodies into the animal, vegetable, and mineral kingdoms. Some great men have aimed to eſtabliſh it as a maxim that there was only one kind of matter differently modified, to produce the aſtoniſhing variety about us. It is certain, it never has been demonſtrated, that either of theſe opinions is infallible, or is more than uſeleſs ſpeculation; but were the combinations, bodies are capable of forming, to be cloſely examined, it would, perhaps, appear both uſeful, and agreeable to the nature of things, to conſider the ingredients that immediately and ſenſibly enter into a combination in any particular proceſs, as the elements of that proceſs, though they are known to be compounds; and the ingredients of thoſe compounds might be conſidered in the ſame manner, notwithſtanding they are known to be compounds themſelves, and continue to deſcend, and as it were feel for the primary elements, as long as experiments can be found to ſupport the theory; from which mode of conſidering bodies, there will reſult a juſt and connected chain of ideas, which will bear the ſame relation to one another as line to line, or ſurface to ſurface, in mathematical reaſoning, and conſequences as exact will follow the data.

A Di-

A DESCRIPTIVE CATALOGUE *of such* SUBSTANCES *as are frequently required, to make* EXPERIMENTS.

The order in which the different ſpecimens are here ſet down, is ſuppoſed to be very convenient for the arrangement of the containing boxes, vials, &c. as the articles which bear a near affinity in their principal uſes or properties, are placed next to one another; there are alſo ſeveral ſubſtances mentioned ſometimes under one general article; this circumſtance ariſes from the leading ſubſtance entering into the compoſition of the reſt: There are many other compound ſubſtances very uſeful to a Philoſophical Chemiſt, that can ſcarely be omitted in a collection of ſpecimens; the compoſition of theſe will be a proper exerciſe to an inquiſitive perſon; this is abſolutely neceſſary in many inſtances, becauſe a perſon may depend upon his own preparations; and that every poſſibility of ſophiſtication may be excluded, every one ought to prepare his compounds for nice purpoſes, in ſmall quantities, by means of the feweſt and ſimpleſt drugs; and even theſe ought to be rendered as ſtrong, or as much concentrated, and as free from foreign matters as their nature will admit of, which, from the late rapid diſcoveries in the properties of different kinds of air, is much more practicable than it was ſome years ago.

MINERAL SUBSTANCES, *moſt of which are, or may be found in the ſtate we uſe them.*

GOLD; A ſmall quantity of this metal perfectly freed from other metals, ſhould be kept always ready in minute grains: Gold leaf will alſo be found upon ſome occaſions very ſerviceable.

PURE SILVER: This is generally ſo when very malleable; and being diſſolved in ſpirit of nitre, is free from cloudineſs and colour;

HORN SILVER: Is an ore of that metal, but not a very common one; may be exactly imitated, by mixing ſpirit of ſalt with a ſolution of ſilver in ſpirit of nitre, and fuſing it.

PLATINA: Is to be procured from the Peruvian mines, and is in many reſpects very like gold; but its colour and ſome of its properties are ſufficiently different to prove it a diſtinct metal.

MERCURY: This fluid metal is very liable to ſophiſtication, but this may commonly be known by its ſurface not appearing very bright, or by a black powder being thrown up to its ſurface by agitation, ſuch as may be given by carrying two or three ounces in a vial, when a perſon either rides or walks a few miles. A ſmall quantity of mercurius calcinatus per ſe; cinnabar; corroſive ſublimate and calomel may be kept as ſpecimens; alſo turpith mineral both unwaſhed and waſhed.

LEAD: That ſhould be choſen which is the moſt malleable; ſome potter's and the white ores; minium, ceruſe and litharge are proper to be always at hand; to which may be added ſaccharum ſaturni.

FINE COPPER: This metal ought to be preſerved in ſhreds, as in that ſtate it is more manageable than in any other; to this may be added ſpecimens of grey and yellow copper ore, cendres bleues and verdegris.

IRON: In the form of ſmall magnets, fine iron wire, bits of poliſhed ſteel, fragments of ſteel ſprings; kidney iron ore, or lapis hæmatites; emeril, colcothar, ocre, and umbre, are neceſſary in a collection.

TIN: Should be choſen in the pureſt ſtate; ſuch as is prepared for the uſe of ſcarlet dyers is the readieſt for chemical purpoſes; but where this cannot be procured, the grained tin ſold at the pewterers will be a good ſubſtitute. The fineſt tin putty, which is known by its clear white appearance ſhould accompany ſpecimens of pure tin.—N. B. As very pure tin is abſolutely neceſſary for ſome purpoſes, it may be proper to melt a ſmall quantity with a very little ſulphur, and afterwards to add a little nitre, and preſerve the tin that is not altered for uſe.

ZINC or SPELTAR: May be procured at the braſs-works, and is known to be pure by its bluiſh hue, and fibrous texture; it is made from lapis calaminaris,

and

and yields a white fibrous ſublimate called flowers of zinc, but not eaſily to be got pure.

BISMUTH: This mineral is known among tradeſmen by the term tin glaſs; regulus of antimony much reſembles, and is ſometimes ſold for, biſmuth, but biſmuth is leſs white, and has ſomewhat of a reddiſh caſt; it melts before it becomes red, which regulus of antimony does not; lead requires a more intenſe heat to melt it than biſmuth does.

REGULUS of ANTIMONY: This ſemi-metal is ſo well known as to require no particular deſcription; both it, and the calx of antimony, are procured from crude antimony.

COBALT: This mineral is not of much uſe in chemiſtry before it is reduced to a kind of calx called zaffre, though ſome is ſo rich as not to require calcination: it may be had at the dry-ſalters, glaſs, and china manufactories, &c.

PYRITES: There are many mineral ſubſtances termed pyrites, very different in their nature; that here meant is the ſhining ſubſtance found in the neighbourhood of Lyme and Charmouth, in Dorſetſhire, and many other places, called pinduſt; it is gathered for the uſe of certain vitriol works: it differs from the mundics by pulveriſing when expoſed to the air.

GYPSUM: When this ſubſtance is to be caſt into moulds to preſerve any particular figure, that is beſt which is very white, and in fine grains when broke, not fibrous; a very ſlight calcination, only 'till it ceaſes to boil, has been found beſt before it is pulverized for uſe.

FLUOR SPAR: May be procured in almoſt every mining country, as Derbyſhire, North Wales, Mendip Hills, and Cornwall: It is readily diſtinguiſhed from other ſpars by emitting a light when put in ſmall fragments upon a piece of iron not quite red hot; it is white, green, blue and purple.

BELEMNITES: Theſe are petrifactions well known to collectors of extraneous foſſils; ſpecimens of them

are ſometimes uſefully preſerved in the cabinet of a philoſophical chemiſt.

QUICK LIME: Is ſometimes found in the earth, but uſually in the lime-ſtone ſtate, either brown, grey, or white; chalk, double refracting ſpar, ſtalactite, ſelenite, and marle contain lime.

PIPE CLAY: Seems to be as free as any ſpecies of argillaceous earth from other ſubſtances; fullers earth, Stourbridge clay, and ſteatite, are of the ſame claſs; however, they all contain ſome cryſtalline ſand when taken out of the earth; and ſometimes inflammable matter.

ROCK CRYSTAL: The freeſt from impurities is the moſt tranſparent and colourleſs; it may be procured in almoſt every mining country, or may be had in the form of fine ſand of thoſe who manufacture glaſs.

MUSCOVY TALC: The beſt is very tranſparent, and divides into thin plates; it may be procured of almoſt every colour.

BLACK LEAD: That is beſt that cuts ſmootheſt, and makes the blackeſt mark upon ſmooth paper; a certain degree of hardneſs is neceſſary.

ROCK SALT: This mineral, as it is found in beds within the earth, varies much in degree of purity; the whiteſt is the moſt free from other ſubſtances; but for experiments, it may be proper to have ſpecimens of every ſort. Bay ſalt contains ſcarcely any thing but marine acid and foſſil alkali, but the fine Droitwich ſalt holds a large proportion of magneſia. Beſides the ſpirit or acid contained in this ſalt, it is very requiſite to have always ready a quantity of ſmoking ſpirit of ſalt in a well-ſtopped vial; the leſs colour, the freer it is from inflammable matter.

ALUM: Freed from its water by calcination, as well as that which holds its water, ſhould be provided. Blue, green, and white vitriol, Epſom ſalt, Glauber ſalt, ſulphur in flowers, and perfectly tranſparent vitiolic acid ſhould be well preſerved.

AMBER: Is beſt ſuited to ſome purpoſes when it is tranſparent, and but faintly tinged yellow, and the deepeſt

deepeſt coloured is the beſt for other purpoſes: the ſame may be ſaid of

COPAL: But in general, the cleaneſt is the beſt.

BORAX: Should be choſen free from colour and in tranſparent cryſtals; it ſhould be kept both calcined and uncalcined:

FOSSIL ALKALI: which ſhould be kept both calcined and chryſtallized.

The following are chiefly Vegetable Productions, many of which require little more to be ſaid of them, in this Catalogue, than the bare mention; becauſe they are nearly the ſame every where.

VOLATILE ALKALI: This ſalt ſhould be kept in its cauſtic, and mild ſtate: it appears to be formed by putrefaction, but is commonly drawn from ſal-ammoniac.

BEES WAX: Some bees-wax is much loaded with honey, and ſome is almoſt entirely freed from it; ſeveral ſpecimens ſhould be kept in readineſs; alſo ſome of the pureſt honey.

CAMPHOR, TURPENTINE, White RESIN, and Ætherial SPIRIT of TURPENTINE, ſhould always be ready; alſo Radical Vinegar.

OIL of LAVENDER; Rectified SPIRIT of WINE perfectly tranſparent and free from an empyreumatic ſcent.

GLUE: The beſt is the moſt tranſparent, and the freeſt from colour.

LUTES: Of different kinds.

ISINGLASS: Should be choſen very white, and in ſhreds for its more readily diſſolving.

MASTIC: Is beſt choſen in ſmall tranſparent yellowiſh grains, quite free from impurities.

ELEMY, GUM GUTTA; GUM LAC; GUM ARABIC.

COCHENELLE: Is an inſect uſed in dying ſcarlet and its ſhades, from which is prepared carmine, employed as a pigment; there are two ſorts of cochenelle, the beſt is of an uniform ſhape, the worſt ſort not being of any particular form.

BRAZIL WOOD; ALKANET ROOT: Such of theſe are to be choſen as give the brighteſt colours to their reſpective menſtrua.

LIGNUM NEPHRITICUM, and BARK of the MOUNTAIN ASH: Theſe communicate a property to water, by which it appears of one colour when it is looked through, and a different one when it is looked upon, but the Aſh Bark has this property in but a ſmall degree.

TURMERIC: This is a root very much reſembling ginger both in appearance and taſte; it communicates a bright yellow colour to water, ſpirit of wine, or to oil, varniſh, &c.

LITMUS: That is beſt which communicates the deepeſt purple to water, and leaves the leaſt ſediment.

SANGUIS DRACONIS: That which breaks with the brighteſt poliſh, and gives the brighteſt orange red to ſpirit of wine, is to be preferred. This drug is often ſold very ungenuine.

ALEPPO GALLS, or GALL-NUTS: Thoſe that are moſt ſolid are beſt; ſome ſhould be reduced to very fine powder, and preſerved in a well-ſtopped vial ready for uſe.

PRUSSIAN BLUE: The deepeſt coloured is beſt.

INDIGO: That ſhould be choſen which is lighteſt and of the moſt vivid colour.—N. B. Indigo is a vegetable production, but Pruſſian Blue is partly animal and partly of mineral produce.

GUM BENZOIN: That is to be choſen which appears to be freeſt from foreign ſubſtances, and contains the greateſt quantity of whitiſh ſhining parts, or that appears to be leaſt porous.

The

The GENERAL SCHEME *of* NATURE.

The EARTH *is formed of the following Subſtances, uſually mixed together in various proportions.*

- TERRENE,
  - *Metallic*,* — Gold, Platina, Mercury, Silver, Lead, Copper, Iron, Tin,
  - *Lime*,†
  - *Cryſtal*,
  - *Clay*,
  - *Uncertain*, — Garnet, Mica, Zeolite, Manganeſe,
- AQUEOUS,‡
- AERIAL,
  - *Fixable*,
  - *Reſpirable*,
  - *Inflammable*,
  - *Acid*,
  - *Alkaline*,
- PHLOGISTIC,§
- HEATING,‖
- LUCID,¶
  - *Red*,
  - *Orange*,
  - *Yellow*,
  - *Green*,
  - *Blue*,
  - *Indigo*,
  - *Violet*,
- ELECTRIC,††
- MAGNETIC;

of theſe, or ſome of them, are formed, — Animals, Vegetables, Minerals.

* Metallics are juſtly eſteemed of a volatile nature; and the calces of metals are conſidered by BERGMAN, SCHEELE, and others, as a kind of very fixed acids.

† Lime is either abſolutely, or ſo far fixed, that no experiment has yet been contrived to render it volatile, when pure; and ſome obſervations ſeem to indicate its converſion, by divers acids, to the other earths.

‡ Water may exiſt in the ſtate of ice, liquid, vapour, or in combination with other bodies.

§ Phlogiſton is found either in combination with other ſubſtances ſo as to produce inflammables, or it exiſts in the ſtate capable of uniting with common air.

‖ Heat

‖ Heat is to be found in the latent, or ſenſible ſtate, and very much reſembles an acid air.—It has been examined by weighing it; and is found to poſſeſs the property of expanding all bodies, except ſuch as contract much by the loſs of a volatile ſubſtance by heating.

¶ Light is found capable of forming an union with ſeveral other bodies, which retain it for a time, and afterwards it is ſet at liberty by heat or decompoſition.

†† The electric and the magnetic effluvia are thought to be the phlogiſton in ſome peculiar ſtates; perhaps combined with heat, &c.

TABLE *of* SPECIFIC GRAVITIES.

Very fine Gold,	19.637	Flint,	2.542
Standard Gold,	18.888	Hard Paving Stone,	2.460
Guinea Gold	17.793	Sulphur Vivum,	2.000
Moidore Gold and Platina,	17.140	Nitre,	1.900
Quickſilver,	14.119	Alabaſter,	1.875
Lead,	11.325	Dry Ivory,	1.825
Fine Silver,	11.087	Brimſtone,	1.800
Standard Silver,	10.535	Alum,	1.714
Copper,	8.843	Ebony,	1.117
Plate Braſs,	8.000	Human Blood,	1.054
Steel,	7.852	Amber,	1.030
Iron,	7.645	Cow's Milk,	1,030
Block-Tin,	7.321	Sea Water,	1.030
Speltar,	7.065	Pump Water,	1.000
Lead Ore,	6.800	Spring Water,	0.999
Glaſs of Antimony,	5.280	Diſtilled Water,	0.993
German Antimony,	4.000	Red Wine,	0.993
Copper Ore, (various)	3.775	Oil of Amber,	0.978
Diamond,	3.400	Proof Spirits,	0.931
Clear Glaſs, (various)	3.150	Dry Oak,	0.925
Lapis Lazuli,	3.054	Olive Oil,	0.913
Welch Aſbeſtos,	2.913	Pure Spirits,	0.837
White Marble,	2.707	Spirit of Turpentine,	0.864
Black Marble,	2.704	Oil of Turpentine,	0.772
Rock Cryſtal,	2.658	Dry Crabtree,	0.765
Green Glaſs,	2.620	Saſſafras Wood,	0.482
Cornelian Stone,	2.568	Cork,	0.240

METALS.

METALS, THEIR

Specific Gravity.		*Phlogiſton they contain.*		*Fuſibility.*	*Malleability.*
Gold,	19.637	Platina,	756	Tin,	Gold,
Platina, (pure)	21.	Gold,	394	Biſmuth,	Silver,
Mercury,	14. 119	Iron,	342	Lead,	Copper,
Lead,	11.325	Copper,	312	Zinc,	Tin,
Silver,	11.087	Cobalt,	270	Antimony (Reg.)	Iron,
Biſmuth,	10.	Manganeſe,	227	Silver,	Lead,
Nickel,	9.	Zinc,	182	Copper,	Platina,
Copper,	8.843	Nickel,	156	Cobalt,	Zinc,
Reg. Arſenic,	8.3	Antimony (Reg.)	120	Gold, Nickel,	Biſmuth,
Reg. Cobalt,	8.	Tin,	114		Reg. Antimony.
Iron,	7.645	Arſenic,	109	Iron, Manganeſe,	
Tin,	7.321	Silver,	100	Platina.	
Zinc,	7.065	Mercury,	74		
Reg. Antimony,	7.	Biſmuth,	57		
Manganeſe,	6.8	Lead,	43		

N. B. An Aqua regia proper for diſſolving Gold, is formed by mixing one part of Sal-ammoniac with three parts of Spirit of Nitre, or by mixing one part of Marine Acid and five of Spirit of Nitre.—Hellot diſſolves Tin one ounce in eight ounces of pure Spirit of Nitre, diluted with eight ounces of pure water, and half an ounce of Sal-ammoniac; Reg. of Antimony is beſt diſſolved by Nitrous Acid four parts, and Marine one; Platina by equal parts of thoſe acids; but the compoſition of this menſtruum is not exactly reduced to rules.

THERMOMETER.

THE uſe of this inſtrument is to meaſure the effect of the ſenſible heat of bodies, by expanding air, quick-ſilver, or metals, to determine its proportion upon different bodies: It is not clear to whom the invention of this inſtrument ought to be aſcribed; it was uſed by Galileo and others, before the middle of the 17th century, but being made to ſhew the expanſion of air, was alſo affected by the variable preſſure of the atmoſphere, which gave occaſion to Mr. Boyle to conſtruct one with coloured ſpirit, which was long uſed before Sir Iſaac Newton conſtructed his with lint-ſeed oil to ſhew greater heats, and to determine the conſtruction of a ſcale that would always expreſs the ſame heat in different inſtruments; becauſe hitherto, tho' Thermometers had been made by divers perſons, no two ſcales were alike, and conſequently were all defective in the important article of communication. Fahrenheit made a Thermometer with mercury inſtead of ſpirit or oil, which ſeems to poſſeſs all the advantages of others, with the addition of more portability, and quicker alteration, which now is almoſt every where in uſe: The ſcale begins at 32 diviſions below freezing rain water, and is numbered up and down from (O), which marks the point where the increaſe begins, and is perfectly convenient to compare one heat with another: But ſince many obſervations have been made with other Thermometers, and that they may not be wholly uſeleſs, the following table will ſhew how to reduce any degree of thoſe mentioned in it to the ſcale of Fahrenheit, extracted from the numbers of the induſtrious Dr. Martine.

M	F.		
		Largeſt Florentine.	B. S.
.857	7.	6.	8.667
		Academy of Sciences.	
.84	21.	25.	11.
		De la Hire.	
1.05	21.	20.	2.6
		Amontons.	
			—339.6
.837	180.	21.5	below (O)
		Reaumur.*	
1.85	19.	10.25	34.
		De Liſle.	
1.2	18.	15.	212.
		Cruquius.	
.41	18.	44.	469.7
		Royal Society.	
.72	32.	44.5	88.2
		Newton.	
5.3	180.	34.	32.
		Fowler.	
1.77	32.	18.	92.4
		Hales.	
1.1	11.	10.	32.
		Edinburgh.	
4.65	65.	14.	14.35

The column (F) ſhews how many diviſions of Fahrenheit's ſcale make the number expreſſed under each Thermometer in the middle column; and (B. S.) ſhews where every ſcale begins agreeable to Fahrenheit's diviſions; ſo that if a number (F) be multiplied into the degree to be reduced, and divided by the middle number, there will be obtained the diſtance in the ſcale of Fahrenheit from the number in column the third, which is all that is required; being the degree in Fahrenheit's ſcale, correſponding to the heat expreſſed by any number belonging to any part of the ſcale of either of the Thermometers in this table; or multiply the given degree by the number in the column (M) and the required number is given by that ſingle operation.

* The mercurial Thermometer of Reaumur has (O) at freezing, and aſcends and deſcends 80 degrees, being equal to 180 of Fahrenheit.

The

The following Heats are expreſſed by the Diviſions of Fahrenheit's Scale.

Metals melt.	
Iron	6494
Gold	1598
Silver	1398
Copper	1348
Regulus of Antimony	805
Zinc	692
Lead	585
Biſmuth	460
Tin	422
Mixed Metals.	
Good caſt Braſs	1049
Silver 2, fine Braſs 1	860
Reg. Ant. 2, Biſmuth 1	752
Tin 1, Reg. Ant. $5\frac{1}{4}$	752
Equal Parts of Tin and Reg. Ant.	635
Reg. Ant. 4, Biſmuth 7	635
Tin 8, Biſmuth, 1	392
Lead 2, Tin 3,	334
Tin 2, Biſmuth 1	334
Biſmuth & Tin eq. parts	283
Tin 5, Biſm. 3, Lead 2	215
Tin 3, Lead 5, Biſm. 8	210
Fluids boil.	
Mercury	600
Lintſeed Oil	600
Vitriolic Acid (ſtrong)	546
Spirit of Turpentine	560
Spirit of Nitre (ſtrong)	242
Oleum tartari per deliquium	240
Sea Water	218
Rain Water	212
Alcohol	174
Ether	100
Water in Vacuo	92
Spirit of Wine in Vacuo	54
Fluids fix or freeze	
Melted Wax	142
Melted Spermaceti	118
Melted Butter	80
Olive Oil	43
Oil of Vitriol	35
Rain Water	32
Blood	25
Sea Water or Milk	24
	Below 0
Spirit of Nitre	40
Alcohol	150
Quickſilv. in Hudſon's Bay	39
According to Bergman	634
Heat of Animals.	
Sea Cow, Sea Calf (Seal), Whales, Land Quadrupeds, Hens	104
Human Body (healthy) from	96 to 98
Bees	
Mean Fever Heat	112
Snakes, Frogs, Tortoiſe	60 to 80
Fiſhes without Lungs	54
Atmoſpheric Heat.	
Greateſt Heat in England	80
Cold in 1709	4
Leaſt (below 0)	3
Spring and Autumn	50
Heat in Caves	53
Greateſt Heat at Senegal	93
Greateſt Heat in the Weſt Indies	100
	Below 0
At Paris, 1709	15
Peterſburgh, 1709	21
Torneo, 1709	29
Upſal, 1740	18
Upſal, 1703	28
Hudſon's Bay	37
Siberia, 1738	118

Vegetables

Vegetables grow beſt.	
Moſt Vegetables ſcorched in	90
Melon, Thiſtle, and Pine-Apple	70
Indian Pepper	66
Euphorbium	64
Cereus, Cucumber, and Amianthus Aloes	60
Myrtles, Ficoides, Oranges, and Sedums	50
Inſide of a Hot-Bed	100 to 142
Hot-Houſe	70 to 80
Miſcellaneous.	
Greateſt Heat produced by a burning glaſs	19482
Glaſs-Houſe Heat for green Glaſs	5694
Welding Heat for Iron	4496
Working Heat for green Glaſs	2847
A ſmall Fire of Pitcoal	1049
Borax becomes a Glaſs	830
Sal ammoniac evaporates	572
Hardened Steel becomes blue	580
Gunpowder Fires	540
Blood, or White of Eggs coagulate	156
Heat of the King's Bath at Bath	119
Buxton Bath	86

N. B. There appears a remarkable Difference in the above Degrees of Heat required to fuſe ſome of the Metals, (and which have been deduced from the Contraction of Porcelain Clay in thoſe Heats) if compared with thoſe deduced by Bergman; but if the Contraction of ſuch Clay be in Proportion to the Intenſity of the Heat it has received, the above Numbers are *nearly*, if not exactly right. There appears ſome ambiguity in the experiments that have been made upon freezing quickſilver, which may be cleared up by future obſervations.

SPECIFIC GRAVITY *of* ACIDS *and* AIRS.

Water being	1.000	Fixable Air,	.0018
Vitriolic Acid,	1.800	Common Air,	.00116
Nitrous Acid,	1.5	Marine Acid Air,	.0012
Marine Acid,	1.187	Pure Air, to common Air, as 187 to 165	.00119
Concentrated Vinegar.		Alkaline Air,	.00113
		Phlogisticated Air,	.00114
		Nitrous Air,	.00115
		Inflammable Air,	.000103
		Elastic and transparent steam from water,	.00009
		Elastic and transparent steam of spirit of wine.	

The PROPORTIONAL EXPANSION *of* AIRS, *with* 10° *of* HEAT.

(FAHRENHEIT's SCALE.)

Common Air,	1.32	Pure Air,	2.21
Inflammable Air,	2.05	Phlogisticated Air,	1.65
Nitrous Air,	2.02	Vitriolic Acid Air,	2.37
Calcarious Air,	2.2	Alkaline Air, (supposed doubtful),	4.75
Marine Acid Air,	1.33		

A TABLE *shewing the* QUANTITY *of* AIR, *&c. different* BODIES *yield, agreeable to the Result of Experiments made by divers Persons.*

Calculus Humanus, *one half its weight.*
Pease, *one third.*
Course Sugar, *one tenth.*
Heart of Oak, *one fourth.*
Water, *the quantity very variable, but often a twelve hundredth.*
Newcastle Coal yields, Air 28, Liquid 12, & Residuum 56.
Box-Wood, —— Air 9, Liquid 61, & Residuum 26.
Limestone, Air 32, Water 15, Lime 50, Crystal 3 per Ct.

A TABLE

A TABLE *that shews the* FORCE *of* COHESION.

Gold,	500	Copper,	290¼
Iron,	450	Tin,	040¼
Silver,	370	Lead,	029½
Yellow Brass,	360		

The following LIQUIDS *rise, in the same* GLASS TUBE, *to Heights that are to one another as the Numbers annexed.*

Common Spring Water,	120	Spirit of Nitre,	85
Spirit of Wine,	110	Spirit of Salt,	90
Vinegar,	95	Oil of Vitriol,	65
Skimmed Milk,	80	Sweet, or Olive Oil,	60

The QUANTITY *of* WATER, *&c. in some* SALTS *and* STONES.

Substances.	*Acid.*	*Water.*	*Earth, or Metal.*	*Remarks.*
Alum,				
Green Vitriol,	¼	¼	¼	Marine acid air decomposes alum.
Blue Vitriol,	¼	¼	¼	
Glauber's Salt,				
Sulphur,	15½	—	—	The rest is phlogiston.
Borax,	—	½	—	Sedative salt and fossil alkali.
Sal-ammoniac,	11½	—	—	16 Volatile alkali.
Fossil Alkali,	—	23	—	10 Acid and alkali. N.B. The acid is fixt air).
Saccharum Saturni,	3	—	—	2 Water & vinous spirit; and lead uncertain.
Selenite,				
White Tartar,				
Epsom Salt,				
Nitrum Argenti,				
Mercu. Nitre.				

The QUANTITY *of* SALTS SOLUBLE *in an* OUNCE *of* WATER.

FAHRENHEIT's THERMOMETER 50 Degrees.

	Grs.		Grs.
Terra Foliata Tatari,	470	Salt of Seignette,	137
Salt of Sedlitz,	384	Blue Vitriol,	124
Epsom Salt,	324	Green Vitriol,	80
Salt of Tartar,	240	Purified Nitre,	60
Vegetable Salt,	212	Salt polychrest of Glaser,	40
White Vitriol,	210	Vitriolated Tartar,	30
Sal-gem,	200	Sublimate Mercury,	30
Salt of Soda,	200	Borax,	20
Sal-ammoniac,	176	Alum,	14
Common Salt,	170	Volatile Salt of Amber,	5
Salt of Glauber,	168	Arsenic,	5
Salt of Lorraine,	168	Crude Tartar,	4
Salt of Sylvius,	160	Cream of Tartar,	3

CERTAIN SALTS SOLUBLE *in* SPIRIT *of* WINE, *and the Appearance of the Flame when burning.*

Soluble in 288 Grs. of Spirit.		Appearance of the Flame.
Vitriolated Tartar,	*Grs.*	
Nitre,	4	*Flame larger, higher, more ardent, yellow, and luminous.*
Salt of Sylvius,	5	*Large, ardent, yellow and luminous.*
Glauber's Salt,	0	*Considerably red.*
Cubic Nitre,	15	*Yellow, luminous, detonating.*
Common Salt,	0	*Larger, more ardent and reddish.*
Vitriolic Ammoniac,	0	
Nitrous Ammoniac,	108	*Whiter, more luminous.*
Sal-ammoniac,	24	
Selenites,	0	
Calcarious Nitre,	288	*Larger, more luminous, red and decrepitating.*
Muria Calcarii,	288	*Larger, more luminous, red and decrepitating.*
Vitriol of Silver,	0	
Nitre of Silver,	84	

Luna Cornea, Mercurial Vitriol, or Mercurial Nitre, are not soluble.

Corrosive

Soluble in 288 Grs. of Spirit.	Grs.	Appearance of the Flame.
Corrosive Sublimate,	204	*Large, yellow, luminous and decrepitating.*
Martial Vitriol,	0	
Martial Nitre,	4	*Red and decrepitating.*
Muria Ferri,	36	*More white, luminous and sparkling*
Vitriol of Copper,	0	
Cupreous Nitre,	4	*More white, luminous and green, much smoke.—The saline residuum becomes black and much burnt.*
Muria Cupri,	48	*Fine green, white and red fulgurations.*

Borax *is soluble in Spirit of Wine, and occasions it to burn green*

How to find the QUANTITY *of* VEGETABLE ALKALINE SALT *in* WATER.

							Grs.
If a Ball of common Flint Glass weighing in air							1000.
be plunged into rain water, it weighs,							710.96
	Parts.		*Part.*				
It weighs in	4	water, and	1	Alkali	-	-	627.4
	5	- -	1	-	-	-	634.6
	6	- -	1	-	-	-	642.6
	7	- -	1	-	-	-	645.5
	8	- -	1	-	-	-	652.
	12	- -	1	-	-	-	657.
	16	- -	1	-	-	-	660.2

The alkali made use of was perfectly mild, and the heat the same in all the experiments made with it, the result of which was as expressed above. Pure rain water dissolves one part of alkali when it weighs 3.3 parts in about 50° of Fahrenheit.

The GRAVITY *of* WATER *and* SPIRIT *of* WINE.

Spirit of Wine. Parts.	*Water.* Parts.	*Specific Gravity.* Parts.	*Spirit of Wine.* Parts.	*Water.* Parts.	*Specific Gravity.* Parts.
16	0	837	7	9	951 2/3
15	1	851 1/2	6	10	959 2/3
14	2	867 1/3	5	11	967 1/2
13	3	881 1/3	4	12	973 1/3
12	4	894 1/3	3	13	979
11	5	907 1/3	2	14	985
10	6	919 2/3	1	15	991
9	7	931 2/3	0	16	1000
8	8	942 1/2			

The

The Specific Gravity of a Mixture of Water and Spirit in 50 degrees of heat being given, the quantity of water and ſpirit mixed together is found by inſpection; and the above numbers will ſerve to calculate intermediate quantities.

Antiseptics.

If Common or Sea Salt be made the Standard, and its antiſeptic power be expreſſed by *one*, the reſt will be as the numbers in the table.

Sea Salt,	1	Salt of Hartſhorn,	4
Vitriolated Tartar,	2	Salt of Wormwood,	4
Spiritus Mindereri,	2	Borax,	12
Soluble Tartar,	2	Salt of Amber,	20
Sal Diureticus,	2	Alum,	30
Crude Sal-ammoniac,	3	Myrrh, Aloes, Aſafœtida and Terra Japonica,	30
Saline Mixture,	3		
Nitre,	4	Camphor, about	300

Chalk and other abſorbent powders have no antiſeptic power, but on the contrary promote putrefaction.

Sympathetic Inks.

Black.

Sal Martis diſſolved, and the vitriolic acid added in a very ſmall quantity, may form an inviſible writing, which appears if the paper be moiſtened with a decoction of gall-nuts.

Common writing ink mixed with the nitrous acid, appears, when bruſhed over with a ſolution of fixed alkaline ſalt.

Biſmuth diſſolved in the nitrous acid, forms an inviſible ink, which becomes viſible by means of phlogiſtic vapours, or by bruſhing over with hepar ſulphuris.

Saccharum Saturni diſſolved in water, after being wrote with, and bruſhed over with any hepar ſulphuris alſo diſſolved, or expoſed to the vapour of it when mixed with an acid, becomes black, or of a deep brown.

Purple.

A ſtrong ſolution of gold in aqua-regia wrote with, and bruſhed over with a ſtrong ſolution of tin in A. R.

Green.

Green.

A writing with zaffre diſſolved in aqua-regia warmed a little, becomes greeniſh, but diſappears when it is become cold again.

PHLOGISTON.

As much has been ſaid of late concerning the Phlogiſton, it was judged neceſſary to give the following view of it.*

There are two diſtinct ſubſtances called Phlogiſton; one of which is a ſimple ſubſtance as far as appears from experiments, and the other is that ſubſtance combined with the matter of heat and light; and in this ſtate it is as frequently called inflammable air as phlogiſton: in the decompoſition of this air, the heat and light are diſengaged from the other ingredient, which in that ſtate is diſſolved by the pure air, mixed with common air; the ſame operation is performed through the coatings of the lungs, and by it the blood is freed from a redundant ſubſtance of exactly the ſame nature with that diſſolved by the common air from burning bodies, and the metals during calcination. The phlogiſton may be combined with the vegetable and foſſile alkalis, calcarious earth, clay, any metallic calx, chriſtalline earth, water, common air, growing vegetables, nitrous acid vapour, and with fixed air when uncombined with light and heat; but it is found in animal and vegetable ſubſtances, in iron, zinc, copper,† &c. in the ſtate of inflammable air.

* Phlogiſton may be paſſed from one ſubſtance to another, with great readineſs, and communicates freſh properties to them, but cannot be procured ſeparate, becauſe there is not known any veſſel that is capable of confining it.

† It is not to be underſtood that theſe ſubſtances which are ſaid to contain inflammable air, do not contain any of the phlogiſton in the other ſtate; they do moſt of them contain ſome of it, and copper contains a great quantity; animal and vegetable ſubſtances contain both in conſiderable proportions, but thoſe that are ſaid to contain one or the other, hold that in the greateſt quantity.

SOLDERS.

SOLDERS.

A SOLDER that melts in boiling water; is compoſed of biſmuth 8, lead 5, and tin 3.

GOOD SOFT SOLDER; $\frac{1}{3}$ or $\frac{1}{2}$ tin, the reſt lead, according to the fineneſs required. It is known to be very good when the ſurface of a piece is ſpotted.

SILVER SOLDER; May be made of two parts pure ſilver, and the reſt very fine ſoft braſs; this may be made coarſer, but it becomes yellow in proportion as the braſs is encreaſed.

SPELTAR SOLDER; Is made with about four parts zinc, and one part copper.

GOLD SOLDER; Uſually contains a large proportion of gold if the work ſoldered be to bear much hammering, but if not, a ſpeltar ſolder may be made to match the colour of the gold, and to run very readily upon it.

N. B. Iron is uſually brazed or ſoldered with the ſpeltar ſolder, or when the joint is required to be very firm, with good ſoft braſs, the zinc in the braſs being the ſubſtance that unites the reſt with the iron.

SUBSTANCES *that are, or may be, applied to reduce* METALS.

GOLD, SILVER and MERCURY; May be reduced, it is ſaid, without addition.

BLACK FLUX; Is tartar two parts, and nitre one part, deflagrated. All the metals may be reduced by the black flux.

TARTAR; Will reduce metals when deprived of ſulphur, without the uſe of nitre; as will alſo ſcrapings of horns and hoofs, charcoal, ſweet or unſulphureous pit-coal, charred peat, cow-dung, &c.*

* Coak is uſed to make pig-iron at Coalbrook-Dale, Wedneſbury, and many other places. Charcoal is uſed in the foreſt of Dean, Sweden, &c. for making pig-iron, and every where in England, to make bar-iron from the pigs. Horns and hoofs, and half-calcin'd bones, are uſed for hardening iron, or partially converting it to ſteel. Peat charred, is uſed in Lancaſhire or Cumberland, to make pig-iron; and ſweet foſſil coal is uſed in Cornwall to reduce the tin-ore to tin, and in Derbyſhire to reduce the lead-ore to lead. Cow-dung mixed with lead-aſhes and burnt, reduces them to malleable lead.

LUNA CORNEA may be reduced to ſilver by a fixed alkali.

IRON ORE of the beſt ſort may be made attractable by the magnet, if heated red-hot, and tallow burnt over it; the ſame is true of calcin'd copperas or Pruſſian blue.

AURUM FULMINANS heated after being mixed with ſulphur, becomes gold without fulminating.

An accurate mixture of tartar, nitre, and crude antimony, produces a regulus of antimony by fuſion; and it appears from writers upon the ſubject, that iron does not only deprive crude antimony of its ſulphur, but alſo converts it to a regulus.†

† Minium or Ceruſe, uſed as pigments in places ſubject to phlogiſtic vapours, become black, being reduced to metal by the vapour.

WEIGHTS.

It frequently occurs in reading chemical treatiſes, that the diviſions of Engliſh and French Weights are mentioned; the following table ſhews what proportion the one bears to the other.

Two Weights are eſtabliſhed in England, the Troy and the Avoirdupoiſe. The Troy Pound is to the Avoirdupoiſe Pound nearly as 88 to 107, and is divided into 12 ounces, the ounce into 20 penny-weights, and the penny-weight contains 24 grains.—The Avoirdupoiſe Pound contains 16 Avoirdupoiſe ounces.

The Paris Pound is to the Engliſh Troy Pound as 21 to 16, or is equal to 7560 Troy grains, it is divided into two marks, that into 8 ounces, the ounce into 8 drams or gros, this into 3 ſcruples or deniers, and the denier into 24 Paris grains.

The Engliſh Medicinal or Apothecary's Pound is the ſame as the Troy Pound, but is divided into 12 ounces, the ounce into 8 drams, the dram into 3 ſcruples, and the ſcruple into 20 grains, which are the ſame as the Troy grains.

The Application of certain Subſtances to ANALYZE *different kinds of* WATER.

EVAPORATION.

Vitriolic Acid per ſe; A volatile vitriolic acid flies off. If water contain vitriolic acid, and a little very finely powdered chalk be added, by evaporation a ſelenite will be exhibited.

Foſſil Alkali per ſe; Cryſtals are formed; which, if a little vitriolic acid be added, will ſhew a true Glauber's ſalt.

Glauber's Salt; Hexagonal cryſtals.

Common Salt; Cubic cryſtals.

Hepar Sulphuris; During the evaporation there is a ſcent not unlike addled eggs.

Copper; *N. B. It is ſuppoſed to be diſſolved by fixed air, or ſome acid.* A greeniſh ſediment, and ſometimes regular cryſtals, according to the acid the copper is combined with.

Iron; *N. B. It is ſuppoſed to be diſſolved by fixed air, or other acid.* A greeniſh ſediment; but the colour is much influenced by the acid the iron is combined with.

Green Vitriol; Regular cryſtals of a ſquariſh and oblong form.

Calcarious Earth, per ſe; The earth is left at the bottom of the evaporating veſſel.

Selenite: A laminated cryſtallization.

Alum; Cryſtals of various figures.

Fixable Air; The air eſcapes during the evaporation, but may be collected.

SOLUTION *of* SOAP *in* SPIRITS *of* WINE.

Vitriolic Acid per ſe; It turns milky. Any ſalt with the marine acid, will have the ſame effect with ſolution of ſoap in ſ. w.

Alum; A browniſh turbid mixture.

VITRIOLIC ACID.

Foſſil Alkali per ſe; A true Glauber's ſalt formed.

Common

Common Salt; The marine acid ſeparates; and its peculiar taſte is communicated to the water.

Hepar Sulphuris; Becomes milky, and emits a ſtrong fœtor.

Copper;—N. B. *It is ſuppoſed to be diſſolved by fixed air, or ſome acid.* A blue vitriol is produced, and may be collected by evaporation.

Iron;—N. B. *It is ſuppoſed to be diſſolved by air.* A green vitriol is produced, which may be collected by evaporation.

Calcarious Earth per ſe; Selenite.

Fixable Air; The acid diſlodges ſome of the fixed air.

Nitrous Acid.

Foſſil Alkali per ſe; Cubic-nitre formed, and at the ſame time an effervescence is produced.

Common Salt; The marine acid ſeparates.

Hepar Sulphuris; Becomes milky, and ſmells ſtrong.

Calcarious Earth per ſe; A terrene nitre, which deflagrates upon burning coals.

Fixable Air; Moſt of the air flies off.

Marine Acid.

Foſſil Alkali per ſe; Common ſalt formed.

Hepar Sulphuris; Becoms milky, and the ſcent is increaſed.

Calcarious Earth per ſe; A Calcarious muriatic ſalt.

Fixable Air; The air flies off.

Fixt Alkali.

Vitriolic Acid per ſe; Glauber's ſalt; which may be known by the form of its cryſtals, after gentle evaporation.

Copper; *N. B. It is ſuppoſed to be diſſolved by fixed Air, or ſome Acid.* A greeniſh colour, or cloud.

Iron; *N. B. It is ſuppoſed to be diſſolved by fixed Air.* A cloudineſs which upon ſtanding becomes ruſty.

Green Vitirol; The iron precipitates of a greeniſh ruſty colour.

Calcarious Earth per ſe; Whether the Earth is diſſolved per ſe, or combined with an acid, mild alkali precipitates it.—N. B. If the alkali be perfectly mild, and the earth diſſolved by fixed air, no change happens.

Selenite;

Selenite; If mild alkali be uſed, there is a very copious precipitate.

Alum; A white earthy precipitate.

Iron *in the* Vitriolic Acid.

Foſſil Alkali per ſe; A yellowiſh precipitate.

Calcarious Earth per ſe; A turbidneſs.

Fixable Air; Iron per ſe, as well as ſome of the other metals, may be diſſolved by fixable air. Such a ſolution of iron becomes purple with gall ſhavings.

Silver *in the* Nitrous Acid.

Vitriolic Acid per ſe; A whitiſh turbidneſs.

Foſſil Alkali per ſe; A milky appearance.

Glauber's Salt; A yellowiſh white cloud.

Common Salt; A copious white precipitate, of a fibrous appearance, and is a luna cornea. This may be readily reduced to ſilver by melting it in a tobacco-pipe with a little pot-aſh.

Iron.—N. B. *It is ſuppoſed to be diſſolved by fixed Air.* A cloudineſs.

Calcarious Earth per ſe; The ſilver ſeparates in the form of a whitiſh cloud.

Mercury *in the* Nitrous Acid, *made with Heat.*

Vitriolic Acid per ſe; At firſt a whitiſh turbidneſs, which, upon ſtanding, turns of an orange colour.

Foſſil Alkali per ſe; A milkineſs.

Glauber's Salt; An orange-coloured cloud.

Common Salt; A white precipitate.

Iron.—N. B. *It is ſuppoſed to be diſſolved by fixed Air.* A ruſty cloud.

Calcarious Earth per ſe; The mercury is ſeparated in a cloud of a yellow appearance.

Vegetable Blues; *as* Solution *of* Litmus.

Vitriolic Acid per ſe; A reddiſh colour.

Foſſil Alkali per ſe; Foſſil Alkali and vegetable blues in general, produce a greeniſh colour; but the colour of a ſolution of litmus is not altered, unleſs it be firſt rendered reddiſh by an acid.

Green

Green Vitriol; When nearly evaporated, a reddiſh tinge is produced.

Calcarious Earth per ſe; A greeniſh appearance.

Alum; A reddiſh colour is produced.

Fixable Air; Changes to a reddiſh colour in a few ſeconds.

Decoction *of* Galls; *or* Gall Shavings.

Copper.—N.B. *It is ſuppoſed to be diſſolved by fixed Air, or ſome Acid.* A faintiſh turbid blue.

Iron; N.B. *It is ſuppoſed to be diſſolved by fixed air.* A deep blue; ſometimes purpleiſh.

Green Vitriol; A deep blue; from its intenſity it approaches to a black.

Alum; A precipitate

Fixable Air; A purpleiſh colour.

Prussian Lixivium.

Copper; N.B. *It is ſuppoſed to be diſſolved by fixed air, or ſome acid.* A dead brown colour.

Iron; N.B. *It is ſuppoſed to be diſſolved by fixed air.* A greeniſh blue.

Green Vitriol; A very deep blue.

Concerning Air.

By heat or diſſolution, ſome ſolids, or ſome of their conſtituents parts, may become elaſtic fluids, capable of further attenuation by heat.

Elaſtic vapour is either ſteam, reducible by cold alone to a groſs fluid, or a ſolid ſtate, or air which cold contracts, but does not intirely deprive of its elaſticity.

Pure Air.

Is procured by moiſtening red lead with a very little water, and pouring about its bulk of very clear vitriolic acid upon it; the air may be ſeparated by a lamp heat, and collected through water. Exploſive mixtures are made by mixing pure air and inflammable air together; the beſt proportion is pure air *one*, and inflammable air *two*. Being mixed with phlogiſticated or fixable air, they become reſpirable; it is heavier than common air, and decompounds nitrous air according as it is better to breathe than common air.

Inflammable Air.

Dilute ſtrong vitriolic acid with three times its weight of water, and pour it upon iron wire of about thirteen feet to the avoirdupoiſe ounce; receive it through water. Two meaſures of common air with one of this, form an exploſive mixture.—Inflammable mixed with nitrous air, burns with a green flame. May be ſeparated from oils by the electric ſpark; is lighter than common air in the proportion of $1\frac{1}{4}$ to one; it is evidently compoſed of light, heat, and phlogiſton, becauſe all theſe appear when it explodes with either common or pure air; it reduces the calces of moſt metals by the burning glaſs.

Nitrous Air.

Strong ſpirit of nitre mixed with four times its weight of water, is to be poured upon iron wire, and the air received through water. One meaſure of nitrous air, and two meaſures of common air, uſually decompoſe one another, the common air diſappearing in part, and the other entirely; and as common air decompoſes nitrous air in proportion to its goodneſs, it becomes an exceeding good teſt to aſcertain the purity of common air.—The electric ſpark diminiſhes it, and the nitrous acid abſorbs it, which by that means becomes greeniſh.

Fixable Air.

If pounded marble be mixed with water and vitriolic acid poured into it, a quantity of air will be diſengaged in proportion to the acid uſed. Water abſorbs a conſiderable quantity of this air during its paſſage through it, but by entirely depreſſing the water from a jar, and ſliding a flat piece of glaſs under it, the communication may be cut off with common air or water, and the fixable air may be kept a long while. This air may alſo be procured by fermentation. It deſtroys animals that breathe it, and extinguiſhes fire; converts lime to limeſtone, and makes alkalis mild; is powerfully antiſeptic, changes the vegetable blues to a red colour; it intirely deſtroys vegetables put into it, and the tender colours of flowers. Its weight is to common air as $1\frac{7}{10}$ to 1. The

electric

electric ſpark contracts it, and renders it immiſcible with water, which is alſo an effect of phlogiſtic vapours.

Marine Acid Air.

The acid of vitriol is to be poured upon common ſalt, and by the application of a ſlight heat from a lamp, this air may be diſcharged, and received through quickſilver into the proper veſſels. If it be mixed with alkaline air, they become ſal-ammoniac; and joined with water, it becomes ſpirit of ſalt. It is heavier than common air, and extinguiſhes fire.—It ſeparates inflammable air from charcoal.

Alkaline Air.

Mix any quantity of quick lime with ſal-ammoniac to abſorb the marine acid, and give the mixture a ſtrong heat from a lamp; this air muſt be received through quickſilver, becauſe it unites readily with water; the electric ſpark, taken through it, enlarges its bulk, and converts a part of it to ſtrongly inflammable air.

Vitriolic Acid Air.

Any ſmall part of a vegetable put into the vitriolic acid, turns it black, and if ſuch diſcoloured acid be heated at a lamp, and the vapour ariſing from it be confined by quickſilver, it is found to be an air that may unite with water or alkaline air; it extinguiſhes fire, and as it is compoſed of the vitriolic acid and phlogiſton, it communicates ſome of that to common air, and injures it; it does not diſſolve iron. The electric ſpark taken through it in a glaſs tube, occaſions the glaſs to be tinged on the inſide of a dark brown or black colour.

Fluor Acid Air.

Fluor ſpar reduced to the fineneſs of coarſe ſand, and covered with pure vitriolic acid, with a lamp heat yields an air that corrodes glaſs, extinguiſhes fire, and is imbibed by ſpirit of wine without ſenſibly altering its properties: it decompoſes nitre. When the fluor acid air is brought into contract with water, a cruſt is immediately formed, which is of the nature of cryſtal.

TABLES *of* SPECIFIC ATTRACTION.

That ſuch tables might be formed, was firſt mentioned by Sir *Iſaac Newton* in his optics, *Quere* 31ſt. They have been gradually improved to the preſent ſtate by divers perſons in ſeveral parts of Europe; and may be conſidered as abridgements of a great number of chemical proceſſes to refer to occaſionally. No degree of heat above that required to keep the ſubſtances fluid and leſs than that which will volatilize them, is capable of altering the order of their attraction as here expreſſed; but when any ſubſtance becomes vapour, the ſcale of attraction commonly varies, and requires a ſeperate table to expreſs the ſeries. Any of the ſubſtances in a ſeries of attraction will unite with the firſt, or menſtruum*, but it is not to be underſtood that they will all unite with one another†; and when two or more ſubſtances are connected by a brace, they are not known to attract the menſtruum with different forces‡. When an elaſtic vapour is diſengaged, and may loſe its elaſticity by cold, it is called ſteam§, but otherwiſe it is true air. The particles of air are kept apart by a repulſive power, but the attraction properly belonging to them does not ceaſe, as is evident by their attaching themſelves to other bodies||, or to one another when in a favourable ſituation;

* As the fixed alkali will unite with vitriolic acid, and detach any of the other ſubſtances from it except kevel; and zinc will detach any of thoſe below it, but not any of thoſe above, becauſe any of them will ſeparate the zinc; as gypſum may be decompoſed by fixed alkali, and blue vitriol may be decompounded by zinc; but white vitriol undergoes no alteration by the addition of iron or copper, &c. See Table 1ſt, Series 1ſt.

† Lead and iron will not unite; Table 1ſt, Series 1ſt.

‡ As lime and manganeſe attract phlogiſton with equal forces; Table 1ſt, Series 12th.

§ Sulphur evaporated from lead or copper ore, or water from moiſt earth are inſtances of this; and true air may be ſeparated from marble or iron by the vitriolic acid, and by heat; the one is fixable air, the other is of the inflammable kind.

|| Fixable air may be readily abſorbed by an alkaline lixivium when a little lime is put into it, and common air by burning charcoal.

and

and in ſome inſtances the attractive and repulſive powers ſeem to act at the ſame time (*).

(*) Alkaline air and marine acid air unite and form a ſolid; but common air and inflammable air unite and retain their elaſticity; common air and nitrous air unite and retain only a part of the elaſticity belonging to the common air, the nitrous air being wholly decompoſed.

TABLE 1ſt.

It is to be ſuppoſed that all the Subſtances in this Table are in the moiſt ſtate, and very pure, unleſs the contrary be mentioned.

SERIES* 1ſt.

Vitriolic Acid.

Heavy Spar or Kevel,
Vegetable Alkali,
Mineral Alkali,
Lime,
Magneſia,
Volatile Alkali,
Zinc,
Manganeſe,
Iron,
Lead,
Tin,
Cobalt,
Copper,
Nickel,
Arſenic,
Biſmuth,
Mercury,
Antimony,
Silver,
Gold,
Platina,
Pure Clay,
Water,
Phlogiſton,

* If phlogiſticated vitriolic acid, nitrous acid, pure or phlogiſticated, diſtilled vinegar, acid of ants, or aqua regia, be put in the place of the vitriolic acid, the ſubſtances below attract any of them in the ſame order; excepting that, phlogiſton is to be omitted under the phlogiſticated, vitriolic, and nitrous, and under the dephlogiſticated marine acids; Mercury under aqua regia; Gold under diſtilled vinegar; Tin, Gold, and Mercury, under acid of ants; and Calx of Iron under both the nitrous acids and dephlogiſticated marine, acid of ants, and diſtilled vinegar.

SERIES* 2d.

Acid of Phoſphorus.

Lime,	Copper,
Heavy Spar,	Nickel,
Magneſia,	Arſenic,
Vegetable Alkali,	Biſmuth,
Mineral Alkali,	Mercury,
Volatile Alkali,	Antimony,
Zinc,	Silver,
Manganeſe,	Gold,
Iron,	Platina,
Lead,	Clay,
Tin,	Water.
Cobalt,	

*The SERIES is the ſame for

- Acid of Fluor Spar, omitting antimony and clay.
- Acid of Arſenic, —— clay.
- Acid of Borax, —— manganeſe, arſenic. biſmuth, antimony. ſilver, gold, platina.
- Acid of Sugar —— gold; add calx of iron between clay & water.
- Acid of Tartar, —— tin.
- Lemon Juice, —— tin, biſmuth, gold.
- Sorrel Juice, —— tin, gold.

SERIES 3d.

Fixed Air.

Heavy Spar,	Manganeſe,
Lime,	Iron,
Vegetable Alkali,	Clay,
Mineral Alkali,	Water,
Magneſia,	Vinous Spirit,
Volatile Alkali,	Eſſential Oil,
Zinc,	Expreſſed Oil.

SERIES† 4th.

Vegetable Alkali.

Vitriolic Acid,	Marine Acid,
Nitrous Acid,	Arſenical Acid,

† The Series is the ſame for the Mineral Alkali; and for the Volatile Alkali; if after Expreſſed Oil, the ſubſtances are ſet in this order, viz. Zinc, Tin, Cobalt, Copper, Nickel, Biſmuth, Silver, Gold, Water.

Acid

Acid of Fluor Spar,
Phoſphoric Acid,
Saccharine Acid,
Sorrel Juice,
Tartareous Acid,
Lemon Juice
Acid of Ants,
Diſtilled Vinegar,
Acid of Borax,
Volatile Vitriolic Acid,
Phlogiſticated Nitrous Acid,
Fixed Air,
Sulphur,
Expreſſed Oil,
Tin,
Lead,
Copper,
Gold,
Water.

SERIES *5th.*

Heavy Spar.

Vitriolic Acid,
Acid of Sugar,
Acid of Fluor Spar
Sorrel Juice,
Nitrous Acid,
Marine Acid,
Phoſphoric Acid,
Lemon Juice,
Tartareous Acid,
Acid of Ants,
Diſtilled Vinegar,
Arſenical Acid,
Acid of Borax,
Volatile Vitriolic Acid,
Phlogiſticated Nitrous Acid,
Fixed Air,
Sulphur,
Water.

SERIES *6th.*

Siliceous Earth.

Acid of Fluor Spar,
Fixed Alkaline Salts.

SERIES *7th.*

Lime.

Saccharine Acid,
Sorrel Juice,
Vitriolic Acid,
Tartareous Acid,
Phoſphoric Acid,
Mineral Fluor Acid,
Nitrous Acid,
Marine Acid,
Lemon Juice,
Acid of Borax,
Arſenical Acid,
Acid of Ants,
Diſtilled Vinegar,
Volatile Vitriolic Acid,
Phlogiſticated Nitrous Acid,
Fixed Air,
Sulphur,
Expreſſed Oil,
Water.

SERIES 8th.

Magnesia.

Acid of Fluor Spar,
Aid of Sugar,
Phosphoric Acid,
Vitriolic Acid,
Arsenical Acid,
Nitrous Acid,
Marine Acid,
Sorrel Juice,
Tartareous Acid,
Acid of Borax,
Lemon Juice,
Acid of Ants,
Distilled Vinegar,
Volatile Vitriolic Acid,
Phlogisticated Nitrous Acid,
Fixed Air,
Sulphur.

SERIES 9th.

Clay.

Vitriolic Acid,
Nitrous Acid,
Marine Acid,
Acid of Sugar,
Arsenical Acid,
Acid of Fluor Spar,
Sorrel Juice,
Tartareous Acid
Lemon Juice,
Phosphoric Acid,
Acid of Ants,
Distilled Vinegar,
Acid of Borax,
Volatile Vitriolic Acid,
Phlogisticated Nitrous Acid,
Fixed Air.

SERIES 10th.

Water.

Fixed Vegetable Alkali,
Volatile Alkali,
Vinous Spirit,
Mild Volatile Alkali,
{ Vitriolated Tartar and Glauber's Salt,
Ether,
Acid of Vitriol,
Vitriolated Tartar,
Alum,
Green Vitriol,
Corr. Sublimate.

SERIES 11th.

Pure Air.

Phlogiston, Fixed Air, Water.

SERIES 12th.

Phlogiston.

Calx of Manganese,
Calx of Mercury,

Dephlo-

Dephlogiſtcated Volatile Alkali	Marine Acid dephlogiſticated
Nitrous Acid	Arſenical Acid
Vitriolic Acid	Phoſphoric Acid
	Water

SERIES 13*th*.

Sulphur.

Fixed Alkali	Volatile Alkalli
HeavySpar	Expreſſed Oil
Lime	Eſſential Oil
Magneſia	Æther
Mercury	Alkahol
Arſenic	

SERIES 14*th*.

Saline Hepar Sulphuris.

Mercury	Vinous Spirit
Arſenic	Water

SERIES 15*th*.

Alkahol.

Water	Fixed Alkali
Æther	Saline Hepar Sulphuris
Eſſential Oil	Sulphur
Volatile Alkali	

SERIES 16*th*.

Æther.

Vinous Spirit	Water
Eſſential Oil	Sulphur
Expreſſed Oil	

SERIES 17*th*.

Eſſential Oil.

Æther	Expreſſed Oil
Vinous Spirit	Sulphur

SERIES 18th.

Oil (unguinoſum)

Æther	Volatile Alkali
Eſſential Oil	Sulphur
Fixed Alkali	

SERIES 19th.

Gold.

Æther	Acid of Fluor Spar
Marine Acid	Tartareous Acid
Aqua-Regia	Phoſphoric Acid
Nitrous Acid	Fixed Alkali
Vitriolic Acid	Vol. Alkali
Arſenical Acid	

SERIES 20th.

Platina.

Æther	Tartareous Acid
Marine Acid	Phoſphoric Acid
Aqua-Regia	Saccharine Acid
Nitrous Acid	Sorrel Juice
Vitriolic Acid	Lemon Juice
Arſenical Acid	Acid of Ants
Acid of Fluor Spar	Diſtilled Vinegar

SERIES 21ſt.

Silver.

Marine Acid	Phoſphoric Acid
Saccharine Acid	Lemon Juice
Vitriolic Acid	Acid of Ants
Nitrous Acid	Diſtilled Vinegar
Arſenical Acid	Volatile Vitriolic Acid
Acid of Fluor Spar	Fixed Air
Tartareous Acid	Volatile Alkali
Sorrel Juice	

SERIES 22d.

Mercury.

Marine Acid	Saccharine Acid

Arſenical

Arſenical Acid	Nitrous Acid
Sorrel Juice	Acid of Fluor Spar
Phoſphoric Acid	Diſtilled Vinegar
Vitriolic Acid	Volatile Vitriolic Acid
Tartareous Acid	Acid of Borax
Lemon Juice	Fixed Air

SERIES 23*d*.

Lead.

Vitriolic Acid	Acid of Fluor Spar
Saccharine Acid	Lemon Juice
Arſenical Acid	Acid of Ants
Tartareous Acid	Diſtilled Vinegar
Phoſphoric Acid	Acid of Borax
Sorrel Juice	Fixed Air
Marine Acid	Fixed Alkali
Nitrous Acid	Expreſſed Oils

SERIES 24*th*.

Copper.

Saccharine Acid	Lemon Juice
Tartareous Acid	Acid of Ants
Marine Acid	Diſtilled Vinegar
Vitriolic Acid	Acid of Borax
Nitrous Acid	Fixed Air
Arſenical Acid	Fixed Alkali
Phoſphoric Acid	Volatile Alkali
Sorrel Juice	Expreſſed Oils
Acid of Fluor Spar	

SERIES 25*th*.

Iron.

Saccharine Acid	Sorrel Juice
Tartareous Acid	Acid of Fluor Spar
Vitriolic Acid	Lemon Juice
Marine Acid	Acid of Ants
Nitrous Acid	Diſtilled Vinegar
Arſenical Acid	Acid of Borax
Phoſporic Acid	Fixed Air

SERIES 26th.

Tin.

Marine Acid	Acid of Fluor Spar
Vitriolic Acid	Diſtilled Vinegar
Saccharine Acid	Acid of Borax
Nitrous Acid	Fixed Air
Arſenical Acid	Fixed Alkali
Phoſphoric Acid	Vol. Alkali

SERIES 27th.

Biſmuth.

Saccharine Acid	Marine Acid
Arſenical Acid	Acid of Fluor Spar
Sorrel Juice	Acid of Ants
Tartareous Acid	Diſtilled Vinegar
Phoſphoric Acid	Fixed Air
Vitriolic Acid	Volatile Alkali
Nitrous Acid	

SERIES 28th.

Nickel.

Saccharine Acid	Lemon Juice
Sorrel Juice	Acid of Ants
Marine Acid	Diſtilled Vinegar
Vitriolic Acid	Arſenical Acid
Nitrous Acid	Acid of Borax
Phoſphoric Acid	Fixed Air
Acid of Fluor Spar	Volatile Alkali

SERIES 29th.

Arſenic.

Marine Acid	Acid of Ants
Saccharine Acid	Tartareous Acid
Vitriolic Acid	Sorrel Juice
Nitrous Acid	Lemon Juice
Phoſphoric Acid	Diſtilled Vinegar
Acid of Fluor Spar	Expreſſed Oils

SERIES 30*th*.

Cobalt.

Saccharine Acid	Lemon Juice
Sorrel Juice	Acid of Ants
Marine Acid	Diſtilled Vinegar
Vitriolic Acid	Arſenical Acid
Nitrous Acid	Acid of Borax
Tartareous Acid	Fixed Air
Acid of Fluor Spar	Volatile Alkali

SERIES 31*ſt*.

Zinc.

Saccharine Acid	Acid of Fluor Spar
Vitriolic Acid	Arſenical Acid
Marine Acid	Acid of Ants
Nitrous Acid	Diſtilled Vinegar
Tartareous Acid	Acid of Borax
Sorrel Juice	Fixed Air
Phoſphoric Acid	Volatile Alkali
Lemon Juice	

SERIES 32*d*.

Antimony.

Marine Acid	Lemon Juice
Saccharine Acid	Arſenical Acid
Vitriolic Acid	Acid of Ants
Nitrous Acid	Diſtilled Vinegar
Tartareous Acid	Fixed Air
Sorrel Juice	

SERIES 33*d*.

Manganeſe.

Saccharine Acid	Vitriolic Acid
Sorrel Juice	Nitrous Acid
Acid of Fluor Spar	Arſenical Acid
Lemon Juice	Acid of Ants
Tartareous Acid	Diſtilled Vinegar
Phoſphoric Acid	Fixed Air
Marine Acid	

TABLE 2d.

As the Proceſſes referred to in the following Table are all conducted in degrees of Heat that will expel Liquids, they are ſaid to be performed by DRY SOLUTION.

SERIES* 1ſt.

Vitriolic Acid.

Phlogiſton	Magneſia,
Kevel	Metals
Fixed Vegetable Alkali	Volatile Alkali
Mineral Alkali,	Clay
Lime,	

SERIES 2d.

Acid of Fluor Spar.

Lime,	Mineral Alkali,
Kevel	Metals
Magneſia,	Volatile Alkali
Fixed Vegetable Alkali,	Clay

SERIES 3d.

Arſenical Acid.

Phlogiſton	Fixed Vegetable Alkali
Lime	Mineral Alkali
Kevel	Clay
Magneſia,	

SERIES 4th.

Acid of Borax.

Lime	Fixed Vegetable Alkali
Kevel	Mineral Alkali,
Magneſia	Clay

SERIES 5th.

Diſtilled Vinegar.

Kevel	Fixed Vegetable Alkali

* The Series for Nitrous Acid, Marine Acid, and Aqua-regia, read the ſame, omitting Phlogiſton in the two laſt.

Mineral

Mineral Alkali
Lime
Magnesia
Vol. Alkali
Clay

SERIES 6th.

Acid of Ants.

Kevel
Fixed Vegetable Alkali
Mineral Alkali
Lime,
Magnesia
Volatile Alkali,
Clay,

SERIES 7th.

Phosphoric Acid.

Lime
Kevel
Magnesia
Fixed Vegetable Alkali
Mineral Alkali
Volatile Alkali,
Clay

SERIES 8th.

Fixed Vegetable and Mineral Alkali.

Phosphoric Acid
Acid of Borax,
Arsenical Acid
Vitriolic Acid
Nitrous Acid
Marine Acid
Acid of Fluor Spar
Acid of Ants
Distilled Vinegar
Siliceous Earth
Kevel
Lime
Magnesia
Clay
Sulphur

SERIES 9th.

Volatile Alkali.

Vitriolic Acid
Nitrous Acid
Marine Acid,
Acid of Fluor Spar
Acid of Ants,
Distilled Vinegar
Sulphur

SERIES* 10th.

Heavy Spar, Cauk, or Kevel.

Phosphoric Acid
Acid of Borax
Arsenical Acid
Vitriolic Acid
Nitrous Acid
Marine Acid

* The same for the articles LIME, MAGNESIA, and CLAY only Sulphur to be omitted under the last of them.

Acid of Fluor Spar	Fixed Alkali
Acid of Ants	Calx of Lead
Diſtilled Vinegar	Sulphur.

SERIES 11*th*.

Siliceous Earth.

Fixed Alkali	Calx of Lead

SERIES 12*th*.

Phlogiſton.

Calx of Platina	Calx of Arſenic
Nitrous Acid	Calx of Nickel
Calx of Gold	Calx of Copper
Vitriolic Acid	Calx of Cobalt
Arſenical Acid	Calx of Tin
Calx of Silver	Calx of Lead
Calx of Mercury	Calx of Iron
Dephlogiſticated Air	Calx of Manganeſe
Calx of Antimony	Calx of Zinc
Calx of Biſmuth	

SERIES 13*th*.

Sulphur.

Fixed Alkali	Cobalt
Iron	Nickel
Copper	Biſmuth
Tin	Antimony
Lead	Mercury
Silver	Arſenic

SERIES 14*th*.

Saline Hepar Sulphuris.

Manganeſe	Antimony
Iron	Cobalt
Copper	Nickel
Tin	Biſmuth
Lead	Mercury
Silver	Arſenic
Gold	

SERIES 15*th*.

Gold.

Mercury	Copper
	Silver

Silver
Lead
Bismuth
Tin
Antimony
Iron
Platina
Zinc
Nickel
Arsenic
Cobalt
Manganese
Saline Hepar Sulphuris

SERIES 16*th*.

Platina.

Arsenic
Gold
Copper
Tin
Bismuth
Zinc
Antimony
Nickel
Cobalt
Manganese
Iron
Lead
Silver
Mercury
Saline Hepar Sulphuris

SERIES 17*th*.

Silver.

Lead
Copper
Mercury
Bismuth
Tin
Gold
Antimony
Iron
Manganese
Zinc
Arsenic
Nickel
Platina
Saline Hepar Sulphuris
Sulphur

SERIES 18*th*.

Mercury.

Gold
Silver
Platina
Lead
Tin
Zinc
Bismuth
Copper
Antimony
Iron
Saline Hepar Sulphuris
Sulphur

SERIES 19*th*.

Lead.

Gold
Silver
Copper
Mercury

Biſmuth	Zinc
Tin	Nickel
Antimony	Iron
Platina	Saline Hepar Sulphuris
Arſenic	Sulphur

SERIES 20*th*.

Copper.

Gold	Tin
Silver	Lead
Arſenic	Nickel
Iron	Biſmuth
Manganeſe	Cobalt
Zinc	Mercury
Antimony	Saline Hepar Sulphuris
Platina	Sulphur

SERIES 21*ſt*.

Iron.

Nickel	Antimony
Cobalt	Platina
Arſenio	Biſmuth
opper	Lead
Manganeſe	Mercury
Gold	Saline Hepar Sulphuris
Silver	Sulphur
Tin	

SERIES 22*d*.

Tin.

Zinc	Manganeſe
Mercury	Nickel
Copper	Arſenic
Antimony	Platina
Gold	Biſmuth
Silver	Cobalt
Lead	Saline Hepar Sulphuris
Iron	Sulphur

SERIES 23*d*.

Biſmuth.

Lead	Silver
	Gold

Gold
Mercury
Antimony
Tin
Copper
Platina
Nickel
Iron
Zinc
Saline Hepar Sulpuris
Sulphur

SERIES 24th.

Nickel.

Iron
Cobalt
Arſenic
Copper
Gold
Tin
Antimony
Platina
Biſmuth
Lead
Silver
Zinc
Saline Hepar Sulphuris
Sulphur

SERIES 25th.

Arſenic.

Nickel
Cobalt
Copper
Iron
Silver
Tin
Lead
Gold
Platina
Zinc
Antimony
Saline Hapar Sulphuris
Sulphur

SERIES 26th.

Cobalt.

Iron
Nickel
Arſenic
Copper
Gold
Platina
Tin
Antimony
Zinc
Saline Hepar Sulphuris
Sulphur

SERIES 27th.

Zinc.

Copper
Antimony
Tin
Mercury
Silver
Gold

Cobalt

Cobalt	Bismuth
Arsenic	Lead
Platina	Nickel

SERIES 28th.

Antimony.

Iron	Gold
Copper	Platina
Tin	Mercury
Lead	Arsenic
Nickel	Cobalt
Silver	Saline Hepar Sulphuris
Bismuth	Sulphur
Zinc	

SERIES 29th.

Manganese.

Copper	Silver
Iron	Tin
Gold	Saline Hepar Sulphuris

A Syllabus of Minerals, agreeable to the lateſt Obſervations, and dependent upon their chemical Properties.

THOSE ſubſtances that are naturally contained in the earth, and make a part of it, are denominated *foſſils*; the true nature of which cannot be aſcertained by external appearance, though it may be uſeful to diſtinguiſh one from another in making collections: they may be formed into four *Claſſes*, viz.

SALINES, which have *taſte*, and are more or leſs ſoluble in water.
EARTHS, uſually inſipid, and not ſoluble in water.
INFLAMMABLES abound with phlogiſton, and burn away more or leſs.
METALLICS do not unite with pure water, but by heat melt with a ſhining ſurface.

SALINES.

ACIDS generally change vegetable blues to a red.
Vitriolic Acid may be phlogiſticated and become air.
Nitrous acid unites with phlogiſton, and becomes nitrous air.
Marine acid, free from water, is marine acid air.
Fluor acid, uncombined with water, is air, that while hot corrodes glaſs.
Arſenical acid is a dry ſubſtance.
Acid of black lead.
Acid of heavy ſpar.
Phoſphoric acid, rarely found foſſil, but abounds in animal ſubſtances.
Acid of borax, is found in ſome lakes, and when pure is a dry ſubſtance.
Acid of amber.
Aerial acid, or fixed air.

Alkalis, uſually change vegetable blues to a green.
Vegetable alkali, not found foſſile.
Foſſile alkali, uſually found combined with the marine acid, but ſometimes pure.
Volatile alkali, is found in clay, ſoot, &c. &c.

Neutral Salts.
Vitriolated tartar, rarely, if ever, found in the earth.
Nitre, very ſeldom found, except in the neighbourhood of putrefaction.
Digeſtive ſalt, rarely found.
Glauber's ſalt.
Cubic nitre.
Mariatic ſalt, abounds in ſea water, ſome ſprings, and forms conſiderable rocks.
Vitriolic Ammoniac.
Nitrous Ammoniac.
Sal-ammoniac.

Borax,

Borax; an acid united with foſſil alkali; but the acid is not ſufficient to ſaturate it.
Mild vegetable alkali: fixed air communicates neutral properties to alkalis.
Mild foſſile alkali; natron; ſuppoſed to be decompounded common ſalt.
Mild volatile alkali, found in ſome ſprings in the neighbourhood of putrefaction.
Phlogiſticated alkali, very ſimilar to a neutral ſalt.
Gypſum.
Terrene nitre.
Fixed ammoniac.
Limeſtone, or calcarious ſpar.
Epſom ſalt; this abounds in certain ſprings.
Magneſian nitre.
Magneſia ſalita.
Magneſia aerata.
Alum.

Metallic ſalts, are decompounded by phlogiſticated alkali.
Blue vitriol.
Green vitriol.
Ferrum ſalitum.
Ferrum aeratum.
Vitriol of nickel.
White vitriol.
Manganeſium ſalitum.

Triple ſalts.
Marine ſalt mixed with magneſia ſalita.
Epſom ſalt mixed with vitriol of iron.
Alum contaminated by ſulphur.
Alum united with vitriol of cobalt.
Blue vitriol mixed with iron.

EARTHS.

Terra ponderoſa; when quite pure, it much reſembles lime.
Terra ponderoſa aerata, contains water 28, air 7, earth 65; its ſpecific gravity from 3.773 to 4.338.
Heavy ſpar (terra ponderoſa vitriolata) diſſolves entirely in pure, boiling vitriolic acid.

Lime, when pure, does not melt in the fire, but looſes 9-20ths of its weight; diſſolves in 700 times its weight of pure water, and generates heat in the operation.
Calx aerata, is rarely free from iron.
Fœtid limeſtone, or ſpar, united with petroleum (*lapis ſuilis*).
Fluor ſpar, often contaminated with ſiliceous earth, is of a purple, blue, green, or white colour.
Lime, combined with an unknown acid, ſuppoſed to be of a metallic nature.
Calx aerata contaminated with magneſia ſalita.
—— by clay.
—— by ſiliceous earth.
—— by clay and ſiliceous earth.
—— by iron and manganeſe.

Magneſia

Magnesia.

Magnesia aerata; its specific gravity 2.155; contains water 30, fixed air 25, and 45 parts of earth; it does not melt in a moderate heat, but looses 11-20ths of its weight.

Magnesia aerata united with siliceous matter.

Magnesia aerata intimately united with siliceous earth, the soluble part of which dissolves in acids without effervescence *(soap rock.)*

Magnesia united with argillaceous, siliceous, and piritous matter.

—contaminated by petroleam.

Argillaceous earth, (earth of alum) when dry attracts water rapidly; contracts gradually by an increasing heat, and may become hard enough to strike fire with steel; when pure it's specific gravity is 1.305—but clay as found in the earth is generally contaminated with other matters. If after clay has been hardened by heat, and will produce fire with steel, it be melted with a large quantity of fixed alkali, and precipitated by acid, just sufficient to dissolve the alkali, it becomes earth of alum.

Argillaceous earth united with siliceous earth *(pipe clay)*.

— with siliceous earth and iron *(bole)*.

— with siliceous and calcarious matter *(marle)*.

— with siliceous earth and magnesia *(terra lemnia)*.

— with siliceous, calcarious, and magnesia earths *(stone marrow)*.

— contaminated by hepar suluris and repundant vitriolic acid *(alum ore)*.

— contaminated by siliceous matter, pyrites, and petrouleum *(alum slate)*.

— intimately united with less than half its weight of siliceous earth, and a small quantity of mild calcareous earth *(gems)*.—N. B. Gems may be dissolved by microcosmic salt and borax, with the blowpipe; tho' not by the fossile alkali; they are, the rubby sapphire, topas, and the emerald.—The tourmalin holds a middle place between the gems and scherle.

— intimately united with half its weight of siliceous earth, or more, and a little mild calcareous earth *(Scherle)*.

— loosely united with half its weight of siliceous earth, or more, and a little calcareous earth *(Zeolite)*.

— intimately connected with a large proportion of siliceous earth, and a small proportion of magnesia *(Talk)*.

Siliceous Earth; when pure, its specific gravity is 1.975—no acid except that of fluor spar is known to dissolve it—fixed alkali unites with it in either the liquid or dry way; siliceous earth is not simple, but may be considered so 'till experiments are formed to prove its composition.

Siliceous Earth united with very small quantities of calcarious or argillaceous earth *(Quartz)*.

—united with argillaceous earth *(Chalcedony)*.

unite

— united with argillaceous earth and calx of iron *(Jaſper)*.
— loaded with martial earth.
— united with argillaceous, and a ſmall quantity of calcarious earth *(Chert)*.
— united with argillaceous earth, and a little magneſia *(feldſpat)*.
— united with magneſia, mild calcareous earth, fluor ſpar, and alſo with the calces of copper and iron *(chryſopraſius)*.

INFLAMMABLES.

Sulphur; any acid coagulated by phlogiſton into a ſolid form, may be termed a ſulphur: the metals have been by ſome reckoned among ſulphurs.

Phlogiſton ſaturated with vitriolic acid *(common ſulphur)*.
— ſaturated with fixed air.
— joined with the acid of molybdena and the vitriolic acid *(molybdena or black lead)*.

Petroleum.
— pure and ſelected *(naptha or rock-oil)*.
— joined with argillaceous earth *(pit-coal)*.
— united with acid of amber *(amber)*.

Ambergriſe is now aſcertained to be of animal origin, and is ſuppoſed to be the fœces of a ſpecies of whale.

Diamond entirely conſumes by burning, tho' ſlowly, and may with propriety be ranked with inflammables 'till its properties are more particularly aſcertained, and exceptions ariſe.

METALLICS.

Native Gold, containing a little ſilver.
— united with copper.
— united with ſilver and copper.
— united with ſilver, copper, and iron.
— united with ſulphur, by means of iron.
— mineralized with ſulphur, together with ſilver, lead, and iron.

Platina, found native, united with iron, but can be freed from it by art.

Silver, found native, but united with ſome gold.
— united with copper,
— united with ſilver and copper.
— united with iron.
— united with arſenic 6-100ths.
— united with antimony.
— united with arſenic and iron in nearly equal proportions.
— mineralized by the vitriolic or marine acids (*Luna cornea*).
— mineralized by the vitriolic and marine acids and ſulphur.
— mineralized by ſulphur (*glaſſy ore*).
— mineralized by ſulphur and iron (*marcaſitical ore*).
— mineralized by ſulphur and lead (*potter's ore or galina*).
— mineralized by ſulphur and arſenic *(ruby ore)*.
— mineralized by ſulphur, arſenic, and iron *(glittering ore)*.

mineralized

— mineralized by ſulphur, arſenic, iron, and cobalt.
— mineralized by ſulphur, arſenic, copper & iron *(white ore)*
— mineralized by ſulphur, arſenic, copper, iron, and antimony *(grey ore)*.
— mineralized by ſulphur, arſenic, antimony, and iron *(plumoſe ore)*.

Quickſilver is ſometimes found native.
— combined or amalgamated with ſilver.
— mineralized by muriatic or vitriolic acids *(corneous)*.
— mineralized by ſulphur *(cinnabars)*.
— mineralized by ſulphur and iron *(martial cinnabar)*.
— mineralized by ſulphur and copper *(cuprous cinnabar)*.

Lead; found native.
— mineralized by vitriolic acid *(vitriol of lead)*.
— by vitriolic acid and iron.
— by acid of phoſphorus.
— by the aerial acid or fixed air.
— by ſulphur.
— by ſulphur, and holding ſilver *(galena)*.
— by ſulphur and iron, holding ſilver.
— by ſulphur and antimony, holding ſilver *(radiated ore)*.

Copper is ſometimes found native, and generally contains ſome gold or ſilver.
— in the calciform ſtate.
— mineralized by marine acid & argillaceous earth (*micaceous*)
— mineralized by fixed air.
— by ſulphur *(vitreous)*.
— by ſulphur and iron.
— by ſulphur and much iron *(pyritous)*.
— by ſulphur, iron, and arſenic, often containing ſilver *(grey ore)*.

Iron is found native in Kamſkatcha.
— united with arſenic *(arſenical)*.
— with the power of attracting other iron *(loadſtone.)*
— with phlogiſton enough to render it magnetic.
— calciform *(ochrous.)*
— mineralized by fixed air, calcarious earth and manganeſe *(white oar)*.
— mineralized by ſulphur *(piritical)*.
— united with a ſubſtance reſembling iron, that impairs its malleability when cold, and forms Pruſſian blue with phlogiſticated alkali, but is incapable of becoming magnetical.
— calciform phlogiſticated in a peculiar manner; a kind of native Pruſſian blue.

Tin is ſometimes, but rarely found native.
— mineralized by ſulphur.
— Calciform Tin, or native putty.

Biſmuth is found native.
— in the form of a calx.
— mineralized by ſulphur.

mineralized

— mineralized by ſulphur and iron.
Nickel, found native, holding a little iron and arſenic; and may ſometimes contain cobalt.
— mineralized by fixed air.
— mineralized by ſulphur, cobalt, and iron.
Arſenic, native, but holding iron.
— united with ſilver.
— calciform.
— mineralized by ſulphur *(orpiment)*.
Arſenic mineralized by ſulphur and iron (*pyritical*).
Cobalt, found native but holding ſome arſenic.
— mineralized by acid of arſenic (*red ore*).
— contaminated by iron and the vitriolic acid.
— mineralized by ſulphur, arſenic, and iron (*glanz cobalt*).
— minerallized by ſulphur, arſenic, iron, and vitriol (*kupfernickel*).
Zinc; found calciform.
— united with fixed air.
— united with fixed air and ſiliceous matter.
— mineralized by ſulphur and iron (*blackjack*)
Antimony found native.
— mineralized by ſulphur.
— mineralized by ſulphur and arſenic.
Manganeſe found calciform.
— mineralized by fixed air.

An

An INDEX to the ARTICLES.

N. B. THE Plate facing the Title-page contains Two Views of the Furnace (Page 17th) in different Operations; alſo the Tub of Water and it's Appendages of Jars, round-bottomed Vials, Eudiometer, Lamp, &c. mentioned on the ſame and next Pages.

The figure to the right in the next plate is a blow-pipe, which is to be plunged into the tub above mentioned, and the air is to preſſed from the ſtop-cock by the column of water—the two other figures at the bottom *Electrometers*; that to the left is to meaſure the force of electric atmoſpheres, and the other the effect of an electric diſcharge after it has been made—the ſcales at the top are to be cut out of the plate to be applied to real inſtruments.

The Third Plate contains the Figure of an improved Terreſtrial Globe; which requires no particular Explanation, further than to remark that it is furniſhed with a Circle of Illumination, and a moveable Horizon, Sun, Moon, &c. and in ſolving problems is to be turned from Weſt to Eaſt. All the inſtruments contained in the three plates are introduced in the author's courſes with his other extenſive apparatus, and their other uſes explained.